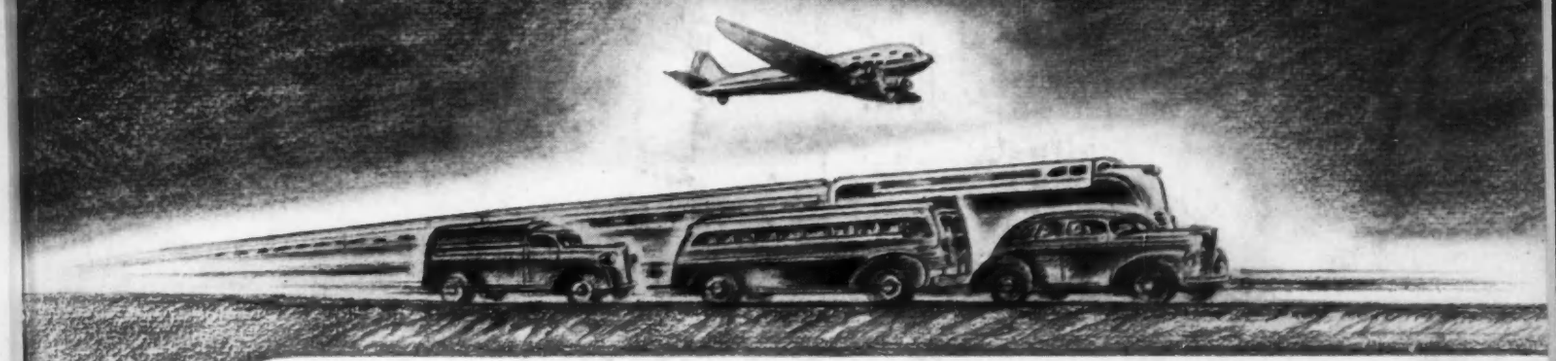
S·A·E Journal



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- Seat Cushions and the Ride Problem — C. R. Paton, E. C. Pickard and V. H. Hoehn
- Economic Aspects of Light Airplane Engines — Carl T. Doman
- Experience on Integral Fuel Tank Construction — Frank C. Albright
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35th Anniversary Issue

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Published Monthly by The Society of Automotive Engineers, Inc.

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About Authors

■ *During the past four years* Frank Albright *has been project engineer on the design of four of the latest airplanes developed by the Vought-Sikorsky organization. When he first joined what was then the Chance-Vought engineering department, he manipulated the slide-rule for a short time, but was soon put in charge of the department. After several years he was promoted to design engineer. During this time, he took on the development of an electrical space-time recorder which has made it possible to develop a very efficient shock-absorbing strut for landing gears. Mr. Albright graduated from the U. of Michigan, Class of Aero '27, and before joining what is now the Vought-Sikorsky organization, he was in Civil Service at Wright Field and in the Aeronautic Branch of the Department of Commerce, with the Hamilton Metal Plane Co., and the Spartan Aircraft Co where he was in charge of the structural engineering section.*

■ *Graduating from the U. of Michigan in 1922 with a B.S. in Mechanical Engineering,* Carl T. Doman *(M '26) took his first job with the Franklin Automobile Co. He started as electrical engineer and, during his 15 years with the company, was promoted successively to the posts of experimental engineer, research engineer, and assistant chief engineer. In 1933, Mr. Doman and Edward S. Marks formed the Doman-Marks Engine Co., which in 1937 became Aircooled Motors Corp., the present builders of Franklin aircraft and commercial engines. Many of the aircooled engine patents formerly held by the Franklin Automobile Co. and now owned by Aircooled Motors Corp. are the inventions of both Mr. Doman and Mr. Marks. In addition to engineering work with Franklin and Aircooled Motors, Mr. Doman carried on a consulting engineering practice in 1932 and 1933.*

■ V. H. Hoehn *worked two years on a surveying party for the North American Power & Light Co. after concluding*

(Concluded on page 40)

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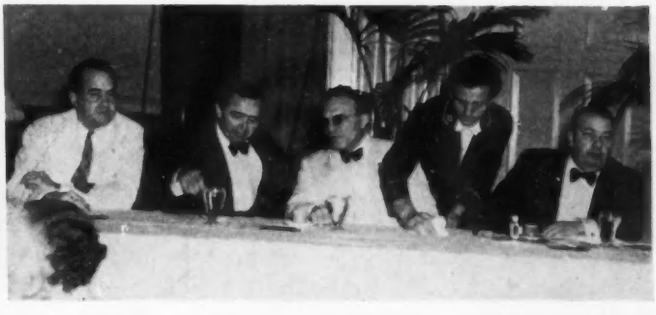
CELEBRATING SAE 35th Anniversary

SAE NATIONAL DEFENSE COMMITTEE Chairman B. B. Bachman cut the Society's Birthday Cake at the opening of the 35th Anniversary Summer Meeting at White Sulphur Springs, June 9, 1940. The new National Defense Committee had just been established by the Council. This committee will coordinate widespread activities already undertaken by the SAE in connection with preparedness and will expedite services in response to new demands for assistance from military and government agencies. On the left is Col. H. W. Alden, chairman, SAE Ordnance Advisory Committee; next is Dr. Robert R. McMath, who showed "The Sun in Motion Pictures." On right is Past-President David Beecroft, principal speaker at the banquet; next, is Past-President W. Guy Wall. SAE President ARTHUR NUTT, away on a European mission, cabled a message to the members at the banquet where Mr. Bachman presided in his absence



OTHERS at the banquet speakers' table were (left to right): Past Presidents H. T. Woolson; W. B. Stout; H. C. Dickinson; J. G. Vincent; Edward Warner; D. G. Roos; R. R. Teetor; and SAE Secretary and General Manager John A. C. Warner

U. S. ARMY OFFICERS consulted with leading SAE members in a series of informal conferences immediately following authorization of the SAE National Defense Committee and appointment of Past-President B. B. Bachman as its chairman. Here are two pictures of the first group called together for informal conversations. Seated directly in front of John A. C. Warner (in the background of the picture on the right) are Lt.-Col. E. E. MacMorland, who led the Army group to White Sulphur, and Mr. Bachman

PREPAREDNESS

MOVEMENT . . . swift, precise, firm movement . . . toward implementation of SAE power for national defense aid flowed out of formal sessions, informal conferences, and official SAE Council and Committee meetings throughout the 35th Anniversary Summer Meeting at White Sulphur Springs, June 9-14.

Flanked by technical sessions keyed to improvement of motor vehicles, aircraft, engines, and fuels – all of which may have some later bearing on preparedness needs – key officers from the U. S. Army, leading engineers and important automotive executives worked, planned, and exchanged vital information throughout the week. One of the first acts of the Council in its meeting on June 9 was establishment of an SAE National Defense Committee to coordinate widespread activities already undertaken by the Society in connection with preparedness and to expedite services in response to new demands for assistance from military and governmental agencies. Past-President B. B. Bachman, vice president of engineering, Autocar Co., was named chairman of the new group. National Defense Committee members appointed by Mr. Bachman to date are Col. H. W. Alden, chairman, SAE Ordnance Advisory Committee; J. H. Hunt, chairman, SAE Standards Committee; and Dr. George W. Lewis, chairman, SAE Research Committee. Other members may be added later as service requirements dictate.

An exhibit of U. S. Army ordnance, brought to the meeting under the command of Major J. K. Christmas, held widespread interest during its four-day stay, while a small group of technicians viewed with deep interest

SAE in National Defense

by E. E. MACMORLAND
Lt.-Col., Ordnance Department

TWO years ago, from this platform, Louis Johnson, the Assistant Secretary of War, expressed the appreciation of the War Department for the cooperation of the SAE in the following words:

"I am very happy publicly to acknowledge the help and cooperation of the Society of Automotive Engineers and to extend to you the appreciation of the War Department for your patriotic services toward development of our automotive program for industrial mobilization in time of war and for current procurement in time of peace.

"Your guidance and intelligent direction have influenced the development of our tanks, our trucks, and our airplanes."

In sending me out here to represent him this year, he asked me to say that the sentiment expressed in these words still reflects the high regard of the War Department for this Society and what it stands for in support of adequate national defense.

What a change has taken place in the two years since that meeting! Munich came shortly thereafter – the rule of force became rampant in the world – small nations were engulfed one by one – Europe today is a shambles – the fate of civilization trembles in the balance. The world wonders where the blow will fall next!

"These are ominous times" is heard on every side as each new triumph of organized force is reported. "These are sad days" was the White House comment when the news came that the Belgian Army had surrendered. Gradually, it began to dawn on us that America had better examine its own state of preparedness. It took a series of severe shocks to arouse our people.

The awakening came with a rush. Only a month ago we still enjoyed the complacent feeling that two broad oceans insured our security. We are not so sure now. War has a greater range these days, and it comes suddenly and in total form – blitzkrieg.

I need not remind you that Congress went into high gear with commendable promptness and voted money and authorizing legislation – $1,800,000,000 for the Army and $1,400,000,000 for the Navy. Hardly was the ink dry on the President's recommendations for these amounts before he realized that he had not asked for enough. The Army needed even more money; so he sent in additional estimates to Congress for $700,000,000 to cover Army needs not visualized in the first hasty estimates.

These are vast sums – yet for the Army they represent only the costs of a minimum thoroughly rounded out Army responsive to current lessons from Europe. They represent the needs to make possible the maximum fighting efficiency of actual forces no greater than already authorized in the National Defense Act of 1920, and essential supplies in reserve for a total of 1,000,000 men. Compared with the equivalent of 38 billion dollars spent by Germany in five years to prepare for war, these sums are relatively modest.

Of the $1,800,000,000 for the Army in fiscal year 1941, all will of course not be available for purchase of armament. A large part will be needed for maintenance of an increased troop establishment. Approximately 2566 airplanes will also be purchased in addition to the 5500 already authorized, mak-

Is Dominant Theme at 35th Anniversary Summer Meeting

an informal demonstration of "black-out" lighting equipment staged by Major Walter C. Thee, Quartermaster Corps, on Tuesday evening.

Twin themes running through the entire gathering were symbolized by the interpretive analysis of automotive engineering development presented by Past-President David Beecroft in his paper, "The Next 35 Years" and by the very specific definition of "The Role of the SAE in National Defense" given by Lt.-Col. Edward E. MacMorland. (Both of these theme-setting papers are printed in full in this issue.)

Topping all recent SAE summer meetings in attendance with a registration of nearly 700, this gathering which celebrated the 35th Anniversary of the Society brought home vividly the vitality of SAE history and traditions in the light of current national problems.

News of technical interest revealed during the meeting included mention of new wide-base rim and tire equipment now emerging from the experimental stage; expression of authoritative opinion that by 1945 gasoline octane values probably will reach a level of 95 for premium grade and 85 to 90 for regular grade motor fuels; announcement that valve stems today are causing 50% of the valve trouble in the automotive field and slightly more than 50% in the aircraft field – but that aircraft valve trouble is far less than valve trouble in the automotive field; and citation of the view that 12 Cooperative Universal Engines have been built and that 10 more are under construction demonstrates the effectiveness of the cooperative method of stimulating and executing cooperative research.

Other authors presented data leading to the conclusion that "no two of the Cooperative Universal Engines as now set up are likely to provide comparative data, and none seems to be sufficiently closely related to multicylinder engine practice to insure comparability of results with the large engine." Other interesting technical contentions made during the sessions included one that "the problem of scratching or scuffing of diesel-engine cylinder liners during run-in of the engine may be largely eliminated through a caustic-sulfur treatment for the honed liners before assembly; another that automobile seat cushion design will and should follow the trend of chassis design toward springs with accurately controlled friction or without friction (coil springs) with the proper amount of damping control; and still another that incorporation of the automobile body floor pan as a structural part of the frame could – with efficient designing – effect of saving of 25¢ to 40¢ per car, but that much development work would be required before a move in this direction would be desirable.

Literally hundreds of other ideas and facts were developed during the 13 technical sessions in which engineering discussion and debate flourished.

■ 35th Anniversary Banquet

Presiding as toastmaster at the 35th Anniversary Banquet in the absence of President Arthur Nutt on a

Lt.-Col. E. E. MacMorland

ing the program 8066. Of the items other than aircraft to be procured, I will mention only the figures for some of the items in which you have a primary interest. There are 31,000 trucks and tractors on hand; this number will be increased to 74,000. Scout cars will be augmented from 485 to 1346; combat cars from 114 to 208; light tanks from 410 to 734; medium tanks from 18 to 194. The program for the supplementary funds recently requested by the President is not yet sufficiently clear to indicate the increased automotive items, except that the aircraft program will be further increased.

With all this money, with the mandate of Congress to hurry along with the job of getting the armed forces into the best possible state of preparedness, a busy year lies ahead. The newspapers tell you almost daily of some new measure to help the cause of preparedness.

(*Continued on page 63*)

European mission, Past-President B. B. Bachman welcomed the members and guests to the banquet, stressed the success of the meeting itself despite a background of grave international disturbances, and emphasized the vitality of the Society's resources for service both to industry and government. He read a message from President Nutt regretting the impossibility of his being present, and a similar message from Past-President Davidson, also in Europe.

More than 200 members and guests attended the anniversary feast, heard Mr. Beecroft vision the progress, past and future, growing from automotive engineering effort, and viewed with deep interest a special presentation of "The Sun in Motion Pictures" presented by Dr. Robert R. McMath of the McMath-Hulbert Observatory and the Motors Metal Mfg. Co.

■ National Defense Session

Introduced by Col. H. W. Alden, chairman, SAE Ordnance Advisory Committee, Lt.-Col. Edward E. MacMorland, Clearance Committee, Army and Navy Munitions Board, brought a specific, practical message to the SAE as regards the many ways in which it can help the national defense program. He stressed his confidence that "the SAE will be in the forefront as always in its service for the national defense." In addition to further expansion of already extensive SAE services to government and military agencies, Lt.-Col. MacMorland suggested: (1) the possibility of an SAE committee to study the best utilization of machine tool equipment now installed, some of which is idle; (2) possibility of an SAE committee to study ways and means to dilute the requirements for skilled labor by breaking down as much as possible skilled jobs into semi-skilled components; (3) that the Society lend its support to the Army's educational orders program which involves only non-commercial military items not normally produced in industry; (4) that the Society help the government by using its influence to prevent re-exportation of strategic materials and by spreading the gospel of conservation; and (5) that the Society put its shoulder to the wheel in filling up the Army on the accelerated recruiting program which must be immediately undertaken. (The full text of Lt.-Col. MacMorland's important message begins on page 18.)

Past-President David Beecroft, Bendix Aviation Corp., delivering his talk on "The Next 35 Years" at the 35th Anniversary Banquet. Seated is Dr. Robert R. McMath who presented "The Sun in Motion Pictures"

■ Business Session

Past-President H. T. Woolson presided at the Business Session on Tuesday evening in the absence of President Nutt.

Presented to the Business Session for their first reading by Constitution Committee Chairman L. C. Lichty were proposed amendments to three sections of the constitution all designed to amplify and make more specific the qualifications required of Affiliate Members and Affiliate Member Representatives. Under the proposed changes a company seeking affiliate membership would be a firm engaged in the automotive or related industries, who, by the nature of its activities, shall be deemed to be concerned with the object of the Society. Representatives appointed by these Affiliate Members would be required to have qualifications "at least equivalent to those for Junior, Associate or Member grade."

The proposed amendment to section C-10 of the Constitution, extending the age limit of Junior members from 30 to 33 years, was submitted by Prof. Lichty for its final reading and, having been approved, will now be sent for mail ballot to the entire voting membership.

■ Photographic Contest

Novel among the social events which featured this 35th Anniversary Summer Meeting was the SAE Journal photographic contest, staged during the Grand Ball on Wednesday evening. Small cameras equipped with flashlight bulbs were furnished to 25 lucky members and each of the 25 contestants shot a roll of eight films immediately. The winning eight pictures are in process of selection by the unknown judges as this issue goes to press – and will be printed in the August issue of the SAE Journal.

PASSENGER-CAR SESSIONS

Chairmen

D. G. Roos **J. C. Zeder**

Criticism of many phases of passenger-car design, and presentation of detailed laboratory data to help design engineers in practical use of rubber, were the topics discussed by passenger-car engineers.

***Design Suggestions Resulting from Road Testing for Safety* – DEAN A. FALES, Massachusetts Institute of Technology.**

"ANY car in good condition is safe if it is handled by a driver who knows his own and his car's limitations," Mr. Fales said early in his critical analysis of automobile design which stressed the handicaps imposed on vision by modern car styling, the possibility of reducing vibration and improving ventilation, the desirability of seats and driver controls readily adjustable to individual needs, and urged production of a special line of cars particularly adapted to bad weather and road conditions – in addition to the regular models which nowadays are all of the "sport" type.

Admittedly influenced strongly by requirements in the Northeastern states, where traffic, road, and weather conditions make sustained high speeds practically impossible, Mr. Fales expressed his

At the Military Session

(Right): Col. H. W. Alden opens the Military Session. At his left is Gen. John L. Hines (retired), who has just become the 11th man in the history of the United States to receive the rank of full general in the American Army. On his right, is Lt.-Col. E. E. MacMorland, the speaker of the evening

(Below): Other officers at the speakers' table during the Military Session were: (left to right): Major Walter C. Thee, Quartermaster Corps; Major M. R. Wood, Air Corps, U. S. Army; Major E. S. Van Deusen, Quartermaster Corps; Major M. V. Brunson, Quartermaster Corps; Major J. K. Christmas, Ordnance Department

belief that "the 50-mph speed limit that is imposed in this section can be accepted as the public's answer to the highway safety problem." Some accidents result from drivers' failing to realize how fast they are going in new cars which make much less commotion than the old ones previously driven, Mr. Fales pointed out. He stressed also that "to properly operate a motor vehicle, both car and driver must be in good condition."

Contrary to many other automotive engineers, Mr. Fales believes that "carbon monoxide has been and still is one of the greatest causes of trouble in motor vehicles." To prevent such troubles, he suggests a wider use of crankcase and breather pipes or crankcase ventilating system exhaust pipes that are connected to the air cleaner or air intake to the carburetor. All station wagons, he urged, should have vertical exhaust tail pipes that expel the exhaust gases at least 6 in. above the roofs of the cars.

Touching upon another phase of the "false-sense-of-security" cause of accidents, Mr. Fales said that "no car can be built low enough that some drivers can not leave the road and turn over."

He stressed a multitude of specific ways in which modern car styling has affected vision adversely mentioning particularly, low seats, slanting glass areas, and high engine hoods. Recognizing clearly the natural opposition of producers to criticism of modern business-creating styles, Mr. Fales showed that "styles not only change, but move in cycles, so it is possible that some of the good features of the older cars may return to public favor."

Summarizing "the wishes and desires of a group of intelligent and thoughtful motorists," Mr. Fales quoted the following:

"Give us the vision, the higher seating positions, the roomier bodies, the greater road clearance, the faster steering, and the weight distribution we had in cars of 12 years ago. Modernize these features, and give us the present smooth and efficient powerplants, transmissions, brakes, and riding comfort." To incorporate the good features of the past with those we now enjoy would not, according to Mr. Fales, present any major problem.

Among the specific design changes Mr. Fales suggested were: windshields which are flat, wide and vertical; other glass areas to be as nearly vertical as possible; either sloping engine hoods or higher seats to give better vision; further development of recently-introduced pressure ventilation systems; further reduction of vibration and body-hum to minimize driver fatigue; more effective windshield-defrosting; faster steering; a smaller moment of inertia and more weight on the rear wheels; greater ground clearance; larger diameter wheels for better traction; room to put tire chains on and room for them to function; more room in bodies . . . and in general cars built with disregard for 100 mph speeds and more useful for our everyday needs.

DISCUSSION

Comments on Mr. Fales' critical analysis of automobile design brought surprisingly few explosive rebuttals, although it was clear that passenger-car engineers present felt that demands of a majority of potential buyers for style and performance must continue to dominate the design picture and that constructions designed to meet those demands cannot profitably be sacrificed despite dissatisfaction of people specialized either geographically or personally. It was equally clear, however, that these same engineers were deeply interested in Mr. Fales' very specific suggestions, a general attitude being expressed by Session Chairman D. G. Roos when he said that such critical studies by a competent outsider are definitely stimulating and helpful.

Several discussions commented on Mr. Fales' contention that carbon monoxide still is a serious problem in modern passenger cars. Austin Wolf agreed with Mr. Fales in this respect, despite improvements made in recent years. W. S. James indicated his belief that Mr. Fales overestimates the seriousness of this particular problem, while T. A. Boyd,

General Motors Corp., in a written discussion submitted in his absence, stated:

"Recent work of Almen and Huber in direct measurement of carbon monoxide in car bodies showed that, in the passenger space of cars in good condition, there is scarcely any carbon monoxide that is detectable. Only in the case of cars in such bad condition as to have a *combination* of leaks in the exhaust system and in the floor, was any significant concentration of carbon monoxide found in the passenger space – and a great many old cars that were in bad mechanical condition were included in these tests. . . . Surveys show moreover that, at 20 to 30 mph road speed, the average percentage of carbon monoxide in the exhaust of 1940 cars is only half what it was in 1928."

In addition to his comment on carbon monoxide, Mr. Wolf voiced agreement with Mr. Fales' contention that false confidence brought to drivers by smoothly running cars is sometimes the cause of accidents; pointed out that accident statistics do not adequately segregate the causes of accidents as between the driver and the car; said that he thinks car stability will be improved by use of the wide-base rims which are under development by important tire companies; stressed the need for more widespread driver education; and agreed that too-low center of gravity is dangerous under some skid conditions.

W. B. Stout, describing what he believed to be an ideal car to meet the criticisms made by Mr. Fales, sketched on the blackboard a rear-engined design closely akin to the Scarab already developed by him.

Walter E. Lay, University of Michigan, pointed out that the slanting windshields criticized by Mr. Fales bring much less disturbing reflections than do straight windshields; admitted that seeing through small rear windows is difficult and constitutes a serious problem; emphasized the importance of "timing" in driving; and pointed out that if a driver doesn't "press" on turns driver fatigue is much reduced. He said, too, that the more relaxed a driver can be, the more alert he is likely to remain, and voiced the belief that the best way to learn to drive safely on ice is to practice deliberately when there is no one else around.

W. S. James, Studebaker Corp., pointed to the difficulty of applying to automobile drivers tests of the rigid character required of airplane pilots, stressing the fact that there are 40,000,000 car drivers and relatively few pilots. Commenting on Mr. Fales' belief that steering ratios are too high and that lower ratios would make for safer driving, Mr. James cited experience with test drivers to support his contention that the higher ratios are just as safe as the lower ones as soon as a driver gets used to them. It is the change in ratio – up or down – Mr. James indicated, that makes for temporary driver uncertainty, not necessarily the progression from lower to higher ratios.

J. H. Hunt, General Motors Corp., in a written discussion read in his absence by Norman G. Shidle, said it is easy to agree that sloping windshields are hard to keep clean under certain weather conditions, but that it is not so easy to believe that vertical windshields could be sold to the public. Commenting on the faster vs slower steering question, he stated: "Personally, I prefer a faster steering, but it is not so easy to be sure that the general public would drive more safely with this faster steering. In many cases it is safer to turn the wheel slightly too slowly than slightly too fast. No doubt the public could learn to use a faster steering, but the safety records might be worse while the learning was in process."

Mr. Hunt admitted that making a car comfortable and quiet at higher speeds has sometimes resulted in accidents, but added: "Few would recommend that this problem be met by restoring the high speed noise."

There is no doubt, Mr. Hunt admitted, too, that greater caster is desirable when driving on soft gravel or snow, but it is very doubtful if the average driver would be satisfied with a car using the extreme caster necessary for the unusually bad road conditions. In fact, it is doubtful if most drivers would permit the maximum caster possible in the range of adjustment provided.

Answering Mr. Fales' criticism of cars without running boards, H. T. Woolson, Chrysler Corp., pointed out that running boards were optional on most makes so that the buyers may take them or leave them as they wish.

J. E. Hale, Firestone Tire & Rubber Co., mentioned the efforts of tire makers to develop the best combination of long life, good performance, and quietness in tires, and said that the wide-base tires now under development would provide longer life as well as greater stability.

Closing the discussion, Mr. Fales paid a high tribute to the tire manufacturers, indicating that tires comprised one part of the modern automobile to be marveled at rather than criticized.

Engineering Properties of Rubber in Compression – **R. W. BROWN, Firestone Tire & Rubber Co.**

"THE engineer can best visualize the performance of rubber when loaded by first considering it as a non-compressible fluid which flows from a region of higher pressure to any available region of lower pressure," Mr. Brown suggested. "Such flow," he continued, "is resisted by stresses within the rubber and by adhesion to the surfaces in contact with the mounting until equilibrium occurs. It is therefore necessary to consider the area and type of contact with the mounting to insure accurate load-deformation measurements." He contended that rates of load application and removal have been used generally in measuring load deformation which are much slower than occur on actual rubber parts in automotive service.

Presenting data concerning the compression characteristics of rubber to aid engineers in incorporating rubber into their products, Mr. Brown defined seven properties of rubber: load deformation; stiffness; hardness; form factor; temperature factor; permanent set; and dynamic properties, including creep.

Discussing hardness, he charged that the generally used durometer method of measuring this property has "serious limitations and low accuracy" when applied to rubber and announced that the SAE is cooperating with the ASTM to improve this condition.

Temperature curves, he pointed out, are not ordinarily required in design computations for rubber parts in motor cars since the rubber functions in a commercially acceptable manner through the range of temperatures to which the rubber is subjected in a motor car.

Mr. Brown's description of apparatus developed to measure the various properties of rubber, illustrated by numerous slides, included dynamic performance-measuring and fatigue-testing equipment.

DISCUSSION

Before introducing Mr. Brown, Chairman Zeder stressed the need for suitable standards for determining and specifying the physical properties of rubber – to aid both the automotive designer and the rubber goods manufacturer. Taking the property of hardness as an example, he pointed out that the durometer gives varied results in the hands of different operators. As other properties of rubber that need clarification, Mr. Zeder named hysteresis, aging, oil resistance, fatigue, and temperature effects.

He announced that a joint committee of the SAE and ASTM is studying the problem and will present its report at the 1941 Annual Meeting of the Society. Because of the extensive scope of the subject, he explained that Mr. Brown's paper covers the properties of rubber in compression only, and that other phases of the problem would be considered later.

Informal Conferences Between Military Men and SAE Members

1 – Ordnance matters were the subject of this informal session 2 – Igor Sikorsky talks with Major M. V. Brunson

3 – Lt.-Col. E. E. MacMorland discusses national defense with W. B. Stout, Edward Warner of the Civil Aeronautics Authority, and SAE General Manager John A. C. Warner

4 – National Defense Committee Chairman Bachman talks on aviation problems with Major M. R. Wood of the Army Air Corps

5 – Col. A. W. S. Herrington and W. S. James

6 – Engineers who talked over mutual problems with Quartermaster Corps officers

Discussion of Mr. Brown's paper did much to clarify definitions and procedures, bringing standardization one step closer.

The first interchange was between Tore Franzen, Chrysler Corp., and Mr. Brown. It concerned, among other things, the natural vibration frequencies of standard 1940 automobile seat cushions. Mr. Franzen reported that, although the frequency values found in his laboratory were of the same range as those reported by Mr. Brown (135-149 cycles per min), they were lower in value. Asked to explain this difference, Mr. Brown opined that it probably was the result of using different methods of measuring the

U. S. ARMY Ordnance Exhibit Forms Background for SAE-Army Contacts

1 – Dr. George W. Lewis and H. J. E. Reid, National Advisory Committee for Aeronautics, view the exhibit with SAE Past-President W. B. Stout

2, 3, and 7 – General views of the Army ordnance exhibit

4 – James M. Crawford, Chevrolet chief engineer, was an early visitor

5 – Active during the meeting were Past Presidents Col. W. G. Wall, D. G. Roos and Col. H. W. Alden

6 – J. E. Hale, Firestone, talks with Major J. K. Christmas, Ordnance Department, and Major M. V. Brunson, Quartermaster Corps

natural frequency of the cushions, giving examples of how the method used might affect the frequency result.

"Rubber company engineers may not realize the serious position in which other engineers find themselves when they desire to use rubber for the first time," averred F. L. Yerzley, E. I. du Pont de Nemours & Co., Inc., adding his voice to those emphasizing the importance of rubber standardization. "Because of the lack of data on rubber properties, such engineers have been known to throw up their hands and use another, less-suitable material in their designs," he continued. Stressing the need for clarification of terminology, he declared that the trouble caused by different interpretations of the same terms is difficult to appreciate. Discussing "modulus," he brought out that tolerances for the modulus of rubber much larger than those held to for steel have been difficult to maintain.

Answering Paul C. Roche, Lord Mfg. Co., Mr. Brown pointed out that the motor-car engineer has to work with a different set of vibration conditions than does the engineer working on stationary equipment. He explained that the data have been reworked to get relative displacements transmitted to "anything but a solid foundation." Cork or felt would not do for engine mountings instead of rubber, he told Mr. Roche, because they do not have its load-carrying ability.

"Instead of the 'simulated anatomy' used by Mr. Brown to load the cushions on his dynamic load-deformation machine, we put a chap in the car who weighed about the same and simulated the critical frequency in the dynamometer," contributed W. E. Lay, University of Michigan. Some method of damping that does not change the frequency of the cushion would be very desirable, he added.

E. G. Kimmich, Goodyear Tire & Rubber Co., asked Mr. Brown whether he had considered adopting the form factor introduced by Walter Keys of U. S. Rubber Co., several years ago. Reporting that his investigations have shown that Mr. Keys' form factor is simpler than the one recommended by Mr. Brown, he urged that it be adopted as a needed standard. Noting that he referred to Mr. Keys' contribution in his paper, Mr. Brown explained that the form factor that he used was selected as the simplest and most convenient to apply to fundamental load-deformation curves. He contended that his form factor "ties into the dynamic qualities with a better bond" than does the Keys version.

A MESSAGE
from Louis Johnson

Assistant Secretary of War Louis Johnson sent the following message to the SAE on the occasion of its 35th Anniversary Summer Meeting:

"In 1938 I had the pleasure of addressing you at White Sulphur Springs and assure you of the appreciation of the War Department for the fine work of the SAE in connection with national defense problems.

"I can assure you that my high opinion of the value of the SAE has in no way diminished in the past two years and I am counting on your continued cooperation in the busy period ahead."

PASSENGER-CAR BODY SESSION

John Oswald, *Chairman*

Two papers in a single session comprised the passenger car body topics. Extensive research results as regards seat cushion contours and constructions were revealed in one paper while elements of cost in various types of body and frame designs were analyzed in the other.

***Riding Comfort and Cushions*—W. E. LAY and L. C. FISHER, University of Michigan. (Presented by Prof. Lay)**

FATIGUE, these authors say, is the sum total of a number of things about which we know very little. Therefore, the designer of springs, shock absorbers and cushions—whose motion, velocity and acceleration may be measured or calculated with fair accuracy—must use this equipment to produce physiological or psychological effects which have no units and cannot be accurately indicated or measured.

Presenting what they described as a progress report on work begun in 1935 at the instigation of the Murray Corp., the authors described in detail methods used in studying the relations between the automobile seat cushion and its function in transporting passengers with greater comfort and less fatigue.

Having come to the conclusion that low unit pressures, not uniformly, but properly distributed over the support area should give the optimum comfort, the problem of trying to determine what is the proper distribution of pressure was attacked. Constructed for this purpose was a piece of apparatus called the Universal Test Seat, whose dimensions were completely adjustable with arrangements to vary the distribution of the supporting pressure in any manner which seemed most comfortable to the passenger.

The authors described in detail the many tests made by use of this apparatus, presented summaries of some of the results recorded and concluded that, to give the passenger the maximum comfort and least fatigue, the following mechanical objectives should be attained by the cushion:

1. To support the passenger over a large area to get the smallest unit pressure on the flesh;
2. To avoid variations in pressure from point to point over the supported area except those variations dictated by actual variations in the body of the passenger. (To obtain the surface contour and pressure distribution on the loaded cushion that is considered by the average passenger to be the most comfortable.)

By extending their analysis of the conditions required for static comfort, the authors believe that the objectives to be attained for dynamic comfort are:

1. To avoid large changes in pressure or forces acting on the body of the passenger with respect to time;
2. Especially to avoid high rates of change, with respect to time, of either the values or direction of pressures or forces acting on the human body.

"We believe the trend in cushion design will and should follow the trend of chassis design," these authors concluded. "Whereas the old chassis springs had excessive friction which varied with use, the present trend is toward springs with accurately controlled friction or without friction (coil springs) with the proper amount of damping for control."

DISCUSSION

Data presented by Messrs. Lay and Fisher in their paper on Riding Comfort and Seat Cushions were described by R. W. Brown, Firestone Tire & Rubber Co., as an important addition to knowledge on this subject which would become a permanent part of the literature. Mr. Brown also pointed out that seat cushions are an important cost element and he feels that the authors' data will provide a basis for real economic gains. He continued that independent checks show surprisingly close agreement with figures in the paper and that, in view of the existence of this information, it is surprising some 1940 cars miss the mark by so much. He also said it was necessary to make static tests first as the authors had done and that dynamic tests would follow in due course. Measurement of unit pressures, he said, gave significant data. It is not unusual,

(*Continued on page* 28)

Then 1905

PASSENGER CAR MAKES – 1905

(Early publications have been the source of this list. The cars named either were listed in connection with the 1905 automobile shows or received mention as "new vehicles" in that year. Gasoline, electric, and steam cars are included.)

Acme
Adams-Farwell
Apperson
Ardsley
Ariel
Auburn
Austin
Autocar
Baker
Banker
Bates
Berg
Berkshire
Black Diamond
Breese & Lawrence
Buckmobile
Buffalo
Buffum
Buick
Cadillac
Cameron
Chadwick
Chicago
Clark
Cleveland
Columbia
Compound
Corbin
Covert
Crawford
Crest
Culver
De Mars
Dolson
Dorris
Duryea
Eagle
Eclipse
Elmore
Ford
Franklin
Frayer-Miller
Gaeth
Gale
Gas-Au-Lec
Glide
Grout
Hammer
Haynes-Apperson
Holsman
Iroquois
Jackson
Johnson
Kansas City
Knox
Lane
La Petite
Locomobile
Logan
Lozier
Manhattan
Marble-Swift
Marion
Marmon
Marsh
Matheson
Maxwell-Briscoe
Meteor
Michigan
Mitchell
Model
Moline
Monarch
National
Northern
Oldsmobile
Oliver
Orient
Overland
Oxford
Packard
Parsons
Peerless
Phelps
Pierce
Great Arrow
Pierce-Racine
Pope-Hartford
Pope-Toledo
Pope-Tribune
Pope-Waverley
Premier
Prescott
Pungs-Finch
Queen
Rainier
Rambler
Rapid
Regas
Reliance
Reo
Richmond
Royal
St. Louis
S & M Simplex
Schact
Speedway
Springer
Standard
Stanley
Stearns
Stevens-Duryea
Stoddard-Dayton
Studebaker
Sturtevant
Synnestvedt
Thomas
Tincher
Toquet
Twyford
Union
United
Upton
Walker
Walworth
Walter
Warren
Wayne
Welch
White
Winton
Wolverine
Woods
Yale
York

IF you had bought a typical "medium-priced" car in 1905, you would probably have paid $1400 and found among its features:

Cost per hp – $70.

Cost per lb – $0.60.

Wheelbase – 90 in.

Tread – 54 in.

Bodies – Open, all-wood . . . no windshield . . . side or rear entrance . . . right-hand drive . . . top, side curtains, and rubber storm apron, extra.

Paint – 27 painting operations taking 35 or 40 days.

Headlamps – Kerosene wick carriage lamps or acetylene gas lamps with gas generator . . . brass . . . plain glass front, no lense . . . single beam . . . maximum intensity of beam 1500 cp.

Tires – High-pressure clincher type . . . smooth tread . . . 30 x 3½ in. . . . 4-ply woven fabric . . . pressure, 70 lb per sq in. . . . average life, 3000 miles.

Wheels – Wood, artillery type.

Starting – Manual . . . by removable crank . . . inserted at side.

Engine – 2-cyl horizontal opposed, 20 hp at 900 rpm. . . . 5½ x 6 in. bore and stroke . . . mounted horizontally amidships under the body . . . compression ratio 3 or 4:1 . . . cylinders cast separately . . . integral cylinder head.

Lubrication – Splash . . . from oil pan . . . no pump or troughs.

Generator – None.

Batteries – Dry-cell.

Fuel system – Gravity, gasoline tank under front seat.

Carburetor – Float feed . . . hand control.

Transmission – 2-speed and reverse planetary . . . spur gears . . . gearshift lever mounted on right outside car . . . progressive shift.

Drive – Single chain.

Brakes – Mechanical external-contracting type . . . on rear-wheel hubs and transmission.

Equipment

Horn – "Bugle" type, brass, with rubber bulb . . . optional.

Speedometer	Optional
Windshield Wiper	(No windshield)
Defroster	None
Heating Unit	None
Oil Filter	None
Gasoline Gage	None
Bumpers	None
Direction Signals	None
Radios	None
Cigar Lighters	None

1940 Now

WHEN you buy a "medium-priced" car today, you pay $850 to $900 and find among its features:

Cost per hp – $9.

Cost per lb – $0.28.

Wheelbase – 116 in.

Tread – 59 in. (rear).

Bodies – Closed, all-steel . . . left-hand drive . . . safety plate glass . . . two or four side doors.

Paint – Finished in synthetic enamels or lacquer in less than half a day.

Headlamps – Sealed beam . . . 6-v electric . . . double beam . . . deflected traffic beam and straight-ahead country beam . . . average maximum beam intensity 60,000-65,000 cp . . . beam indicator signal light . . . foot-pedal beam control.

Tires – Low-pressure balloons . . . anti-skid tread . . . 4-ply cord . . . 6.00-16 . . . pressure, 27 lb per sq in. . . . average life, 20,000 miles.

Wheels – All-steel welded, disc type.

Starting – Electric self starter.

Engine – 6-cyl in-line vertical developing 95 hp at 3400 rpm . . . 3 7/16 x 4½ in. bore and stroke . . . mounted under hood . . . compression ratio 6.10:1 . . . cylinders cast en bloc . . . removable cylinder head.

Lubrication – Pressure . . . 34 lb per sq in. at 30 mph . . . geared pump.

Generator – Shunt type . . . 35-amp. . . . voltage and current regulation.

Batteries – Storage battery.

Fuel system – Fuel-pump pressure system . . . pump driven from engine camshaft.

Carburetor – Plain-tube . . . dual-downdraft type . . . automatic choke and air cleaner.

Transmission – 3-speed and reverse . . . constant mesh . . . synchronized shift . . . helical gears . . . steering-column-mounted gear-shift lever . . . selective shift.

Drive – Propeller shaft, universal joints, hypoid gears.

Brakes – Four-wheel hydraulic . . . internal-expanding type.

Equipment

Horn – Twin electric . . . high note and low note . . . standard.

Speedometer	Standard
Windshield Wiper	Standard
Defroster	Optional
Heating Unit	Optional
Oil Filter	Standard
Gasoline Gage	Standard
Bumpers	Standard
Direction Signals	Optional
Radios	Optional
Cigar Lighters	Optional

PASSENGER CAR MAKES – 1940

Bantam	Buick
Cadillac	Chevrolet
Chrysler	Crosley
DeSoto	Dodge
Ford	Graham
Hudson	Hupmobile
LaSalle	Lincoln
Lincoln-Zephyr	Mercury
Nash	Oldsmobile
Packard	Plymouth
Pontiac	Studebaker

Willys

1905 - 1940

PARTS manufacturers and material suppliers, working side by side with motor-vehicle designers, have multiplied motor - vehicle values many times in 35 years. Time after time they have met "impossible" demands for new strengths, improved performance, lower prices.

The results of their combined achievements show up dramatically when the vehicle of 1905 is compared with the vehicle of 1940.

(*Continued from page* 25)

he stated, to find pressures of 50 lb per sq in. on persons with bony body structures, such pressures being highly uncomfortable.

T. C. Smith, American Telephone & Telegraph Co., asked if work had gone far enough to justify attempts to build cushions for testing under practical conditions. Mr. Fisher said some cushions had been built and that, while they were not entirely satisfactory, very good results had been obtained.

Norman G. Shidle, SAE Journal, asked whether the results would have been changed if the test machine had had a hood in front of it. Prof. Lay replied that purposely a hood was not used because of the many variations in hood design. He said he felt that the cushions should be designed to provide comfort and that the design of the hood should be such as not to interfere.

Following Chairman Oswald's summarization, Prof. Lay said that one main fact could be stated: If the proper pressure distribution is found for the average person, the proper contour for that person has been established. The converse is also true, he added.

Comparative Weight and Cost of Body and Frame – **H. B. BARTLETT, Parish Pressed Steel Co.**

INCORPORATION of the body floor pan as a structural part of the frame, omitting it from the body, could – with efficient designing, effect a saving of 25¢ to 40¢ per car, Mr. Bartlett said, but cautioned that a very considerable amount of development work would be required before a move in this direction would be desirable.

Service costs have no relation to overall car stiffness, he proved by quoting specific service cost records. From this fact, he drew the conclusion that "any car which has an overall rigidity sufficient to give satisfactory performance during the development stage will not have a large service cost that can be charged directly to a weak frame and body construction."

Concluding, Mr. Bartlett emphasized the desirability of standardization of body and chassis parts, provided engineering improvements are not impeded and model individuality is not lost. By standardizing only the front cross bar and the side bars on two different frame designs, he showed, a tool proration saving of 18.5¢ per unit could be achieved in a run of 100,000 frames.

Commenting on recent discussion of unit frame-body designs, Mr. Bartlett expressed the opinion that, "for the time being at least, the separation of these units is highly desirable."

AIRCRAFT-ENGINE SESSIONS

Chairmen

N. N. Tilley **Robert Insley**

A picture of the altitude performance that can be expected from aircraft engines a year from now was portrayed in two papers presented at the first session. The first covered ground-boosted liquid-cooled engines, and the second, air-cooled types. A wide difference of opinion as to the causes and cures of valve deposits was evident from the paper surveying the problem read at the second session. Two papers on the Cooperative Universal Engine (C.U.E.) – one outlining its development and construction and the other comparing installations in the various laboratories – completed the program for the final session.

Altitude and the Aircraft Engine – **EROLD F. PIERCE, Wright Aeronautical Corp.**

"THE aircraft-engine manufacturer's 1 lb per hp at sea level, which is not an impractical possibility, becomes 2 lb per hp at 20,000 ft unless the utmost in engineering skill and ingenuity is put into the problem of increasing altitude output," Mr. Pierce brought out in his introduction.

Comparing the effects of various methods of supercharging upon the engine power output and specific fuel consumption, he concluded that, as operating altitudes are increased, either the two-stage supercharger or the exhaust turbo method of supercharging appears to be required. For high-altitude operation, he believes that the exhaust turbo in conjunction with the two-stage supercharger seems to offer the maximum in horsepower output, but with considerable installation complication. He added that, for low-altitude operation, the "single-speed non-intercooled engine offers the maximum output with a minimum of installation complication."

One of the most retarding forces to accelerated development toward improved economy and higher specific output is the difficulty of obtaining precise and comprehensive data under actual flight conditions due to the lack of suitable flight test facilities and of time itself, Mr. Pierce contended. The capital expense necessary to provide one or more airplanes suitable for modern engines, he explained, is almost beyond the realm of possibility, and the time element cannot be overcome at the present pace of the industry which is concentrating on development of new types of engines.

In a summary of the empirical methods of portraying engine characteristics, Mr. Pierce revealed that data obtained in flight with the torque meter provide excellent substantiation of the empirical formulas used for the determination of engine performance at altitude. He showed that fuel consumption at altitude is related definitely to the power and speed values required for the airplane operation. He brought out that, for a given supercharger blower ratio, the minimum specific fuel consumption values are obtainable only at the lower altitudes, and curves of engine fuel requirements must be correlated suitably with the altitude power curves of the engine before such curves are of practical use.

Altitude Performance of High Output Aircraft Engines – **RALPH N. DuBOIS, Aviation Mfg. Corp., Lycoming Division.**

CONTINUED development of intercoolers and methods of supercharging will allow satisfactory altitude performance to be maintained in the face of future requirements, Mr. DuBois assured his audience. Early in his presentation, he explained that his paper deals principally with a description of the methods used in, and a discussion of the results of, an investigation of the possible altitude performance with liquid-cooled engines of high output and consequent high ground boost.

As the first step in the investigation of altitude performance, he said, the power of the engine cylinder under all possible conditions of manifold pressure, manifold temperature, and exhaust pressure must be determined. Describing the single-cylinder laboratory at his company's plant with the aid of a slide, he brought out that it is possible to produce in this laboratory any desired exhaust suction; manifold pressures up to 150 in. hg; inlet air temperature up to 400 F; and to handle engine speeds up to 5000 rpm.

Maintenance of power at altitude by means of the exhaust-driven turbo compressor, Mr. DuBois believes, affords a most convenient way out for the engine manufacturer; the troubles, if any, are transferred to the builder of the turbo and of the airplane. He considers "worthy of considerable attention" the use of a two-stage supercharger with an auxiliary engine to drive the first stage. He explained that this arrangement is especially applicable to large airplanes.

Other supercharger arrangements discussed are the single-stage geared compressor; two-speed drives; continuously variable drives; two-stage geared superchargers; and modified two-stage installations, such as two-speed both stages, bypassed first stage, and the two-speed first stage.

The two-speed first-stage method of using two stages is the most satisfactory yet considered, Mr. DuBois opined, since three steps of supercharging reduce the amount of throttling required and, therefore, improve the overall efficiency of the system.

DISCUSSION

High praise for the two papers came from Robert Insley, Pratt & Whitney Aircraft, and P. B. Taylor, Wright Aeronautical Corp. Mr. Insley termed them successful efforts in cutting through theoretical "abracadabra" to predict the performance of aircraft engines at altitude, and Mr. Taylor suggested that the accuracy of the results obtained without "suitable flight test facilities and test airplanes," the lack of which was decried by Mr. Pierce, would seem to indicate that these facilities might not be needed.

Noting that the curves of power versus altitude for two methods of supercharging displayed by Mr. Pierce showed

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by DAVID BEECROFT

Bendix Products Division, Bendix Aviation Corp.

CELEBRATING the 35th Anniversary of the founding of our Society inspires a feeling of genuine appreciation – appreciation arising from the realization that our lot, in the endless span of centuries, was cast at a time when it was possible to make so far-reaching a contribution to the progress of mankind as automotive products have made.

It has been our fortunate experience to have been major actors in a transportation drama, the shifting scenes of which have transformed the face of our countryside; revolutionized urban transportation; created a network of over 1,000,000 miles of paved highways; completely altered national distribution of commodities; removed the isolation of nearly every area of our land; effected the conquest of the air by heavier-than-air craft, and replaced century-old methods in agriculture.

It has been our fortunate lot to have been leaders and cooperative contributors in the exploration of the sciences and the development of the arts, the results of which have made the motor vehicle, the airplane, and other applications, the world-changing influences that they have been.

Should we not then in humility record, on this Anniversary, our sincere appreciation for such a life opportunity?

It is appropriate at this time that we pay grateful respect to those pioneers whose vision 35 years ago conceived the necessity for an organization such as our Society has become today.

It is also appropriate that we record the honor due to those inspired spirits, with us no more, who in the formative years of our growth gave their best and laid broad and sound the basis of our scope and objectives.

Thirty-five years constitutes, in human reckoning, a generation, and their completion marks an opportune time to take inventory, to measure what we have accomplished, to make certain of our position today, to ascertain the incentives that spurred us on, and to give thought to the courses to pursue in the future.

It is an accepted maxim that the roots of the present are found in the past and that some clue to the future may be had by relating the trends of today to the accomplishments of yesterday. The more familiar we are with the accomplishments of yesterday, the more paths can be discerned leading toward the progress to be attained.

That the progress of the last 35 years has been unprecedented no one will question, and that more progress has been made in a generation in transportation than had been accomplished in previous centuries, is not disputed.

In searching for a key, with which to unlock the reason for such a world-altering revolution, the word cooperation is most expressive of the energies, the vision, the will-powers, and the continuity that have made it possible.

Our Society stands as a symbol of such cooperation in engineering, in research, in standardization, in education, and in national defense.

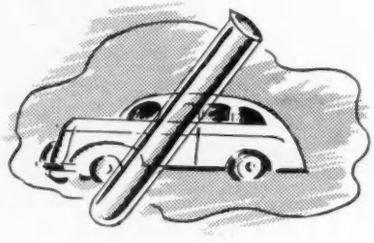
We are but one of the organizations within the sphere of our industry that have made cooperation a corner-stone of their functioning. Perhaps it was the memory of the havoc wrought by disunity previous to the Selden patent decision in 1911 that impressed the importance of unity and cooperation so deeply on automotive men. The long regime of cross-license agreements of patents among manufacturers since then is one example of cooperation among rivals. The united support of a highway construction program by our manufacturers is another.

Within our Society we have over 150 different committees, national and sectional, representing one-third of our total membership – all coming under the banner of constructive cooperation. Many have been functioning for 30 years. We cooperate with regulatory authorities including Federal and state groups. We cooperate with our national defense services. We cooperate with fuel producers and consumers. We cooperate in national and international standardization and research. Our entire existence has been one phase or another of cooperation.

In briefly scanning the past 35 years in searching for the roots that have been responsible for the growth of today, the conclusion is that evolution, standardization, and research have been determining factors. Let us clarify this statement: The development of the motor vehicle – that is, the passenger car, the truck, and the bus – has been an

evolution as compared with that of the airplane and modern fuels in which research has been the dominant factor. From the beginning research has given us the science of aerodynamics as expressed in the plane. Research has made possible the fuels we use.

Automobiles



FROM the earliest types of motor vehicles our makers inherited their first conceptions of engines, transmissions, axles, steering, and so on, and the work of 35 years has been developing these components in function, in design, in materials, and in accuracy and speed of manufacture. In this evolution over 1500 patents have played their part.

In scanning this evolution of the motor vehicle, let us consider briefly the three major stages of this 35-year growth: First came the stage that we designate as the fundamental, which ended about 1911. Ten years before our Society was formed France had produced the general chassis plan – engine, clutch, gearset, transmission, rear-axle propulsion, and steering system. This layout has continued for 50 years.

Before 1911 the multicylinder engine was in use; the V-type engine was on the road; the progressive gearset had given way to the selective; the cone clutch was losing out to the disc clutch; shaft drive had replaced the chain; the electric generator for lighting was in use; unsatisfactory four-wheel brakes had been tried out in Europe; and the electric horn, magneto, demountable rims, front bumpers, ignition locks, four-door torpedo-design bodies, speedometers, shock absorbers, clocks, asbestos brake lining, and many other accessories had appeared. The winning of the Dewar trophy in 1907 by a U. S. car demonstrated that the consciousness of and necessity for interchangeability of parts were realized. The standards of adequate shop practice were well illustrated by this victory.

The second stage began in 1911 and continued until the early 'twenties. For lack of a better name it is called the development stage in that, during those 11 years, the passenger car was so developed as to meet the needs of any adult – male or female.

The key to this stage of development was the electric starter which set in motion a train of evolution intended to make the car adequate for all. It was the pace-setter that made imperative a revision of many parts of the vehicle, to meet the whims and desires of a public which almost over night became conscious of the universally broadened field. When the starter became standard equipment, sales increased 60% in a single year.

The train of evolution that followed in the wake of the starter was rapid and broad.

Electric lighting became general; the closed body was an essential. Fortunately the cord tire by the late teens was in general use, providing increased mileage, the cord structure replacing square-woven fabric, and the use of gas black in tread rubber gave added mileage. The expected mileage of 3700 at once stepped up to 7500. The construction of 250,000 miles of paved roads created an irresistible desire for car ownership and travel. The introduction of instalment purchasing made the desire for ownership an easier reality. The progressive assembly line enabled makers to meet the new buying demands.

The evolution in design was continuous, and manufacturers were responding to the public's increasing demand for quieter vehicles, better riding qualities, more power. The closed body precipitated the demand for lessened noise. One manufacturer anticipated this demand and produced the spiral-bevel rear-axle gear in 1912. Vibration dampers appeared on engines. Nickel plating on radiators and lamps, vacuum fuel-feed tanks, and other devices simplified vehicle operation and maintenance.

The third stage dates from 1922, or thereabouts, and has continued up to the present. It is designated as the research stage. Fuel research has been the pace setter in this stage, but the contributions of highways, tires, and brakes merit a definite place. Researches in metallurgy contributed much to make the progress possible.

Fuel research dates from the first use of the cracking process, or pressure distillation, in 1913. From that date to 1921, the possibilities of fuel research were carried on by individual companies and, in 1921, the creation of what is known as the Cooperative Fuel Research started and has produced in two decades a world revolution in fuels which has made the power of our present engines possible. The fuel revolution, in turn, set in motion a virtual avalanche of improvements that have made necessary new designs in nearly all parts of the vehicle. Fuels have been the dictators. They have made it possible to increase engine compression ratios from, say, 5.3:1 to 6.9:1, which has increased engine horsepower per cubic inch piston displacement 30%. As a result top-speed possibilities of cars have risen from 55 to over 85 mph.

The new fuels demanded new valve materials that are capable of withstanding high critical temperatures, oxidation, and corrosion; and possess good seating qualities. The increase of compression ratio has demanded better bearing materials, increased bearing areas, closer manufacturing limits, stronger materials, and new designs.

The demands of increased power and speed and the necessity for longer life have spurred bearing manufacturers to higher levels of accuracy, and today the X-raying of plain bearings to detect porosity or other defects has arrived. In ball-bearing manufacture the human equation has given way to electronics in inspection for specification limits and smoothness of surface. Surface finishing of many parts is contributing to quieter operation and increased life.

The added power called for reduction in vibration, and rubber mountings and more rigid frame construction resulted. Improved lubricants and increased carburetion also were necessary.

Fortunately, before the influence of new fuels was felt, other related developments had been accomplished. The balloon tire appeared in 1923 and, with its low pressure, was ready to meet the speed demands made possible by a billion dollars a year expenditure in paved highways. Four-wheel brakes, arriving the next year, provided control for higher speeds and increased power. Spray painting, introduced the same year, made volume production with reduced body building space possible.

Higher speeds and greater traffic density created demands for increased control, greater safety factors, and easier riding. In response, came the all-steel body in 1924; easier gearshifting in 1928; and lower bodies made possible by hypoid gears and wheel-diameter reduction from the 19-in. diameter of 1928 to the 15 and 16-in. diameters of today, which effected a reduction of 33% in wheel weight.

The demand for quiet operation introduced helical transmission gears and a program of sound deadening in body design.

Increased speeds paved the way for non-shatterable glass, interior ventilation without drafts, and tire tread designs to give quietness and non-skid qualities. Higher engine speed brought on the overdrive, which made possible a 30% reduction in engine speed with maintained car speed. The quest for a better ride and better steering control precipitated the independent wheel suspension of 1934.

Power expenditure for increased speeds initiated the streamline movement that got under way in 1933, and in the train of which has followed the parade of fashion satellites – the radiator grille, fender headlights, inadequate bumpers, and the score of body designers' delights. Out of it all has come provision for the much-needed baggage compartment that also houses the spare wheel or wheels.

The body designers have made a worthy contribution in increasing body width, and the revival of the 35-year-old mounting of the gearshift lever on the steering column has made the three-passenger front seat an unembarrassing reality. Body stylists have the task ahead of designing less vulnerable fenders and of providing greater accessibility and improved vision.

Continuation of the gearbox discussions that started 35 years ago have resulted in a slow but certain evolution. The work of gearshifting took on a fresh importance in the late 'twenties, by which time the registration of over 23,000,000 vehicles and the general installation of traffic light controls greatly increased the amount of gearshifting, collectively and individually. Synchromesh in 1928, fingertip control, the fluid flywheel, and lastly the automatic shift eliminating the clutch pedal, represent steps in a long-looked-for advance.

The highway modernization program, already drafted for the next two decades, in which city express highways will be a definite part, will materially contribute to the ease, pleasure, and speed of motor-vehicle operation.

We are at the beginning of a new evolution – that of air-conditioning of passenger cars. That there is a need for it in certain seasons is evident. That there will be a demand for it from the public is certain. The motor-vehicle manufacturer has never failed when such a situation has confronted him. He will not fail this time. One manufacturer already offers a mechanical system at extra cost and for factory installation only. Like the proverbial young bears, air-conditioning has its troubles ahead. The relatively short period when it is needed in some parts of the country brings the cost consideration into the consciousness of the buyer. The air-conditioned intercity bus is already the pace-setter. The manufacturer will prove capable of overcoming the probable cost hurdle.

This survey of the roots of the past and of the trends that we are in the midst of indicates that the incentives to continued research and evolution will include fuel, lubricants, speed, a better ride, greater comfort, safety, and economy. Style, like the poor, will always be with us. Each of these incentives, as in the past, will demand new designs, revisions, and the use of new materials. Research will produce new materials and new processes that will result in competition among materials and, as in the past, some materials will be removed from positions that they have held for years. This competition, heretofore non-existent before industry became aware of the competitive value of applied science, introduces upsetting factors, that come as a bolt from the blue. It represents another stage in the complexity of industry.

The developments ahead will consist of a cooperative complementary evolution, evolving from the roots of the past and the trends of today, plus those industry-disturbing introductions of new products of research that will become pace-makers and will set in motion engineering revisions that may embrace many parts of the vehicle.

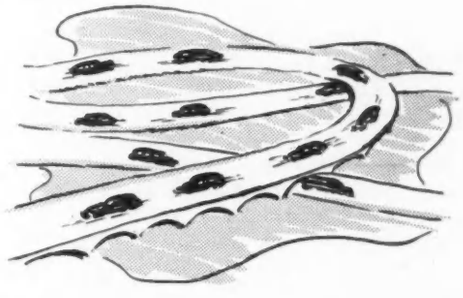
The national economic picture will exert its influence, particularly as taxes rise and the margin of the individual's available purchasing money narrows. Economy in first cost and in operation and maintenance will have to be considered. These may dictate much revision in design and manufacture.

With indications for a long swing of comparatively level fuel prices with higher octane ratings, perhaps as high as 90 for premium fuels, the decision will have to be made whether to go to higher compression ratios or to smaller engines with superchargers. Metallurgical and lubricant researches may determine the selection.

A complete revamping of the passenger-car layout may be an eventual pathway; it may follow a chassisless plan and break away from the tradition of the forward vertical engine and embrace a new arrangement of major components that will provide new body arrangements.

Metal spring suspension may have to meet the competition of synthetic rubber-like products that hold possibilities of a far-reaching character. The wider invasion of rubber products is definitely under way. The possibilities of plastics are largely in the lap of research.

Highways



IN the march of progress there are coincidences of occurrences that stimulate cooperation which in turn produce stupendous results.

It may be merely a coincidence that in 1892 the first gasoline automobile was built in the U. S. A.; that in 1893 the Department of Agriculture in Washington set up the nucleus of what has become the present Public Roads Administration; and that in 1893 a patent was issued covering the conception of the cord tire.

The reconstruction of communal and industrial geography that has resulted in the past 48 years through the evolution of the germs of these three concepts almost exceeds the limits of imagination.

The trinity of cars, tires, and highways has demonstrated what the will of man can accomplish.

These three sounded the signal to ring down the curtain on the dark ages of highways that existed from 1840 to 1900.

Let us scan the highway epic:

Two decades were needed to sell the good roads idea. By 1910 the politicians started talking. In six years we got the Federal Aid Highway Act and by 1921 the money provided through the Federal Aid Highway Act was available. Since 1922 we have expended over a billion dollars a year in highways. The job has been well done.

When the war ended in 1918 there were 250,000 miles of surfaced roads. Today there are 1,100,000 miles or over, one-third of the entire rural mileage. Over 90% of our population lives within 10 miles of some part of the system. Rural roads carry 70% of our travel, and city, town, and village streets carry 30%.

The dependence of human and industrial existence on the motor vehicle, the highway system, and tires, is illustrated by two examples: Over one-half of the communities in North Carolina have no railroads and are served 100% by motor transportation. In Utah, one populated area larger than the State of Connecticut and entirely settled since the advent of the motor, has never had a railroad.

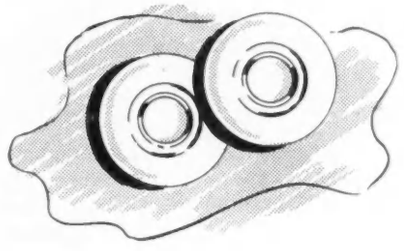
Highway progress will continue to march on to 1975 and beyond. A constructive program of national scope for the next 25 years already has been drafted. It is a program based on highway and traffic research – on facts and not on opinions or on pork barrels. It is a program made possible by highway planning surveys already completed by 47 states, all directed and coordinated through the Public Roads Administration.

This program is not one of extending the present system of 1,100,000 miles, but rather a plan to modernize this mileage, much of which is not adequate for present traffic. The program embraces construction of adequate multi-lane divided highways leading to centers of population and at other necessary locations; easing of the curvatures to admit of higher sustained speeds with greater safety and lessened congestion; reduction of gradients to permit sustained speeds without traffic dangers; and extending of sight distances to provide additional safety and conservation of drivers' mental and physical energy.

But this is only one part of the program. City, town and village bottlenecks are to be attacked. The construction of express highways through cities and other centers of population will be carried out and bypass roads will be built, along which the construction of retail centers will be prohibited in order to maintain the intended value and capacity of the bypass. The express highway developments of New York City and St. Louis have planted the germs of what will in the next 35 years eradicate the economic loss due to traffic congestion and greatly multiply the use of motor vehicles. What these express highways from the centers of cities to airports will mean to aviation can scarcely be speculated on. They will step up average city speeds from 17 to 40 mph.

The traffic volume and safety advantages of four-lane divided highways over two-lane types indicate a continuing growth of the four-lane divided design. Studies have demonstrated that the same freedom of vehicular movement had on a two-lane highway with a total hourly traffic of 400 vehicles can be obtained by 2600 vehicles on a four-lane road. Doubling the number of lanes increases the traffic capacity 6.5 times. These 2600 vehicles may average 45 mph. The traffic could be raised from 2600 to 6800 vehicles per hour but the average speed would be reduced to 40 mph. With the distribution of speeds normally encountered those traveling at 60 mph would be taken care of. The three-lane highway has no place in the proposed modernization program. Government statistics point to an increase of 80% in vehicle miles per year for the nation by 1960, by which time our estimated population will be 145,000,000 and our motor-vehicle registration 37,000,000.

Tires



THE pneumatic tire, now celebrating its 51st birthday, was conceived to provide some measure of comfort for a boy when riding a bicycle over Irish cobblestones. It accomplished that simple and humane objective and, from that humble beginning, its life has been one continuous contribution to speed, comfort, and safety.

The existence of the motor vehicle depended on it, and tire evolution – accomplished by chemical progress, by textile improvement, by structural design, and by research in pavement adhesion – has exceeded the expectations and anticipations of everyone concerned.

During most of the 51 years since its inception, the pneumatic tire has been a consistent running mate with its two contact relatives, the highway and the vehicle. It has been the go-between.

Thirty-five years ago tire makers were engaged in the study of the relative merits of the clincher and the straight-side types, at which time the attachment of the tire to the wheel was the major problem. The clincher came out first, but the wire bead principle of the straight-side type gained headway and, in a decade, the clincher faded out of the picture. Then followed the prolonged battle for rim designs, the detachable flange, the transverse split, until finally the practice set by one car maker of using the drop-center rim started a new trend which is today in universal use.

Fortunately tire improvement synchronized closely with the car developments: Soon after the pace-setting march started by the electric starter was under way, the use of cord fabric instead of square-woven design was introduced and was in general development from 1913 to 1918. At the same time the great chemical advance in the use of gas black for tread stock gave an added wearing life. These two more than doubled available tire mileage, which was so necessary due to the increased use of motor vehicles.

In the early 'twenties when highway building had attained its stride and vehicle speeds were rising, the study of efficient and safety treads was under way and the rib tread design was the outcome. Contemporaneous with this development came the balloons with low pressure, greater comfort, added safety, and increased life.

As vehicle makers stepped up production because of

standardization and line assembly, tire makers kept in step. By 1910 tire-building machines were in the experimental stages of rapid development, and a 10-year progression produced the drum method of tire building in use today. It brought economies and greater uniformity.

The rubber chemists, too, were busy, and chemicals known as accelerators speeded up the curing process. Anti-oxidants improved the aging qualities, prolonged tire life, and imparted additional desired characteristics. These are but a few of the contributions of chemistry.

It is only when we contemplate how great inventions such as these have complemented one another in time, that we find the key to why the motor industry has had such a record-making evolution in a single generation.

The introduction of the balloon tire in 1923 caused tire noises to become disturbing factors, and the improvement in tread ribs provided the solution. Tread research spread to tire profiles with pronounced shoulders, and so treads designed for advertising uses were replaced by those designed for service. Balloon tires, introduced on 20-in. wheels had cross-sections approximately thrice that of the high-pressure types replaced. During the decade of the 'twenties wheel reductions were still further reduced to the 15 and 16-in. sizes of today.

By the late 'twenties the pneumatics for trucks, the development of which began in 1915, were in general use.

The tire industry typifies what would seem to indicate the existence of a basic law of economic necessities – that is, when a product to meet new and more stringent service is demanded, such a product is forthcoming. The patent on the cord structure, obtained in 1893, required over 20 years of development before it was in general use; yet it was ready when annual vehicle production passed the million mark, when pavements were increasing, and when traffic congestion was in the offing.

Although the cord-tire concept dates from 1892, it was almost 40 years later that the discovery was made that the merit of the cord consisted not so much in the use of long-staple cotton, but rather in the structure of the cord. It was discovered that medium-length cotton staple with more twists and less cord elongation was the key to better wear.

Some five years ago consideration was given to the possibility of using rayon because of its higher resistance to heat, and today rayon has been developed to a point where it appears to do everything that cotton will. It has the present handicap of higher cost.

Tire valve development is deservedly the ace of automotive standardization as measured over a span of 42 years. The valve interior or core of today fits the valve housing of 1898 with equal facility, thanks to the tire makers recognizing from the first the mandatory necessity for such interchangeability. It was in the middle 'twenties that Europe met the American standards, and so today the removable valve cores and the cap, with the tire valve housing comprise the only standard in world-wide use in the automotive industry.

Not content with more than achieving every requirement and expectation in the motor-vehicle spheres, the pneumatics have invaded agriculture and today 90% of the current production of farm tractors use them. While adding 12 to 15% to the delivered price of the tractor, the pneumatic tire brings many advantages that more than offset this increase. The pneumatic allows for lighter weight using less metal. On an estimate of 5000 hours of useful life, the reduction in fuel consumption will more than offset the higher original cost. This calculation is based on a 25% saving in time to perform a given amount of work, with a 25% saving in fuel.

What of the next 35 years?

The answer rests in the lap of research, the human will to progress, and the manufacturing will to produce the products evolved by research. Rayon fabric with its heat-resisting advantages is the first gift of research. It is certain that the closely twisted cotton cord of today will disappear, and that with it may go the necessity for the spare tire, provided adequate self-healing tubes may be forthcoming.

Synthetic rubber will be produced to possess most of the qualities of natural rubber and, in addition, the ability to resist heat, oils, solvents, and aging.

It seems certain that the transitions from the use of natural rubber to synthetics and from cotton to rayon will be gradual. Who can estimate the acreage of forest that would be needed to meet our annual tire requirements if rayon were used entirely, but it is obvious that our nation would have to enter upon a commensurate re-forestation plan to supply the demand.

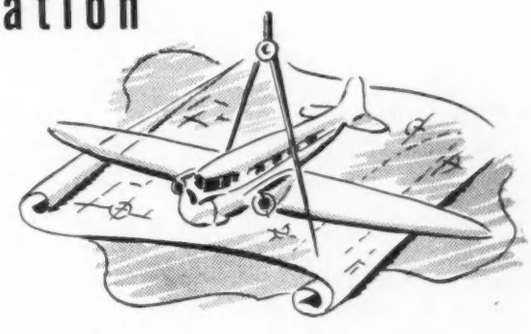
It is further certain that synthetic grades of rubber will be produced that will broaden the field for the use of materials similar to rubber. Today two synthetic rubber-like products, examples of what may be expected, possess many but not all of the desirable properties of rubber and, in addition, are resistant to hydrocarbon solvents and oils and have higher resistance to heat.

These materials are produced by polymerization processes, similar to what is taking place in fuel production, and we may expect to learn of new wonder products arising from changed molecular arrangements and combinations. Our rubber seems destined to come from our oil wells and forests rather than from the plantations of Africa and the Orient, or the jungles of the Amazon.

Since 1919, when cord tires were in general use, the attained road mileage per tire has consistently increased in annual increments of 600 to 1000 miles. It started at 7500 miles, based on limited records of some leading tire sizes, and today the 22,000-mile tire is a possibility, but not attained by the average motorist. Tire mileage availability has, in short, doubled during each of the last decades.

During those 20 years average wholesale prices show a present reduction of 30%. In 1933 average wholesale prices were less than one-half of the 1920 level. The cost per tire-mile in 1940 is approximately one-quarter of that in 1919.

Aviation



AVIATION, since the historic flight at Kitty Hawk in 1903, owes its major advances to researches, governmental and industrial, in contrast with the motor vehicle where continuous evolution has been the dominant factor.

Governmental and industrial research must be intimately related at all stages of development to the whole-hearted and determined will of manufacturers to accept, produce, and constantly improve upon what research has evolved if the maximum is to be accomplished. The aircraft manufacturers have done this commendably.

A great contribution was the pioneering instinct, the experimentation, the courage, the business acumen, and the inspiration of those men who brought into being, and who are operating, the transport systems of today. These systems would not have been possible had it not been for the skill, the daring, the will to succeed of the pilots who have made our transport service world-famous.

Following the Kitty Hawk flight, the further evolving of the science of aerodynamics of aircraft had to be worked out. It had to be researched and written. This was a start from scratch, to borrow a sporting term, compared with the beginning of the motor vehicle.

Two outstanding accomplishments, both products of governmental research, have contributed largely to the aerodynamics of the present plane: One is the engine cowling for the radial engine which became a reality in 1929 and which at once increased speeds of then-existing planes 20 mph without added engine power.

The other research accomplishment resulted in 1932 in the formula determining the correct location and relationship of engine nacelle and propellers to the wings on multi-engined airplanes. This formula and the engine cowling had international adoption and stepped up cruising speeds of transports from 120 to 180 mph and, on some of the modern types, from 200 to 250 mph. This formula has given a stability to plane design as it sets forth the correct relationship of such airplane parts. It has provided the key to economic performance and has contributed definitely to safety.

A third major contribution, and it came from industrial inventions, is the controllable-pitch propeller. Up to its installation in 1933 the airplane had operated, without a gearset, if a parallel may be used, and it was a compliment to the resourcefulness of manufacturers and pilots that flying was possible for so many years without a change-speed equivalent. After 48 years of evolution the gear box is still a necessity in motor vehicles. The reversible propeller is giving real service in providing speedy maneuverability for sea craft when in the water.

To these advances in aerodynamics must be added the high-octane fuels, products of the CFR research, and the intense program of engine design, made mandatory if the potentials of the new fuels were to be efficiently used.

The supercharger, since its general adoption in 1925, has added 5% to engine weight, 10% to engine cost, but has doubled the available horsepower at altitudes of from 16,000 to 25,000 ft. Improved fuels, improved engine design, and metallurgy have permitted doubling the mean effective pressure and thus the horsepower of a given engine since 1925.

Altitude flying has made mandatory carburetor designs, evolved within the past 5 years, that incorporate automatic altitude controls; that meet all requirements for maneuverability in civil and military operation; and that prevent icing and boiling of fuels. Economy with such designs has resulted in reducing fuel consumption from a range of 0.52 to 0.48 lb per hp-hr to a range of 0.43 to 0.41 lb per hp-hr. Here is a reduction in fuel load that provides for an increase in tariff load. Engine speeds are up 50% giving piston speeds of 2500 fpm. Present engines give 0.66 hp per cu in. of piston displacement, but new ones in the near future will give 1.1 hp per cu in. displacement, a power increase of almost 70%.

In aircraft-engine design the engine weight has been cut in half since 1925. Airlines which used 73-octane fuel in 1930 today use 87-octane fuel, and 100-octane fuel is used by the defense services.

Let us list a few of the engine developments: Cylinder-head cooling area increased five times; lubricants that increase periods between engine overhauls 50%; the development over a decade and a half of forged light-weight pistons; salt-cooled valves that give 40,000 miles of service without attention; and the reduction of engine vibration by the use of the dynamic crankshaft balancers that make the using of higher engine power a reality.

Engine power will continue to increase. We will have bigger and more luxurious planes, but few of such types. There will be a few aerial Normandies or Queen Marys, and the possibilities of such Leviathans are assured.

With pressurized cabins, flying at 20,000 ft has been attained. Wing loading has increased from 11 lb per sq ft in 1929 to 30 lb per sq ft today. Landing speeds, that were 50 mph, are now 70 mph, and they will probably stabilize between 70 and 80 mph. Without wing flaps, landing speeds could not have been maintained so nearly constant when the higher power, increased weight, and higher speeds are considered.

Retractable landing gears have made possible speed increases as high as 30 mph at given high rates of travel. This advantage is reduced at lower speeds.

An important change in operation is the growth of instrument flying which spells the gradual discontinuance of contact flying in transport service with the consequent reduction in the use of the lighted beacons that have been the guides for night flying.

In radio the current trend is towards ultra-high-frequency equipment which gives a more accurate beam condition. Radio aids for land navigation are being gradually changed over from low to high frequency.

All transport routes are now fitted with radio range beacon equipment, which makes blind flying a reality. What is now awaited is the long-delayed blind-landing equipment which is under special investigation at the present time.

The tricycle landing gear, introduced by one of our members some years ago, has been applied to transport designs and its use affords better vision for landings and preserves the level flight position of the plane when on the ground. It minimizes the possibility of the nose-over when landing.

De-icers have taken their place in the safety equipment of the plane and are in general use on transport lines.

The spectacular progress of the past 15 years cannot be expected to continue at such speeds, but progress will march on, with smaller increments of gain.

Cost of plane structure manufacture must be reduced. Cooperative investigation to this end is already under way. The millions of rivets will give way to welding. Large units in wing and fuselage design will replace hundreds of small parts. Here is where the experience of the automobile industry can be used to advantage.

Now let us scan what this epic of transport research, engineering, and manufacturing has meant when translated into operating progress.

In the past 13 years airway-miles of transport routes domestic and foreign have risen from 3700 to 84,000, a

23-time increase. Of these 84,000, our domestic mileage is 36,000 of which 75% are lighted.

While transport route mileage has multiplied 23 times in 13 years, miles flown by planes have similarly increased, and passengers carried have catapulted from 6000 to 1,800,000 or increased 300 times. The record of 15 months of transport flying without a fatality gives inspiring indication of the growth of air travel in the days ahead.

Transport airlines are making money, thanks to the production in 1936 of what has been accepted as a plane design that gives promise of setting a standard for some years. Our airlines are outstanding examples of sound economic operation.

With the modern 1936 design of plane, an airline operating on a 60% passenger load basis makes money. The most efficient operation makes money on a 50% passenger load basis. Some may say this is due to mail contracts and that the dividends come from the post office. But consider the record: One of our best operations received 27% of its revenue in 1938 from mail, and but 22% in 1939. While the mail revenue increased 14%, the passenger revenue increased 43%.

Here is another indication of the upward trend in passenger traffic: In 13 years, fares have been reduced from 12 to 5c per mile, and they will go still lower. The length of the average trip per passenger has dropped from 430 to 395 miles, a certain indication that, in the next 35 years, the automobile will have the planes as a contender in short-distance service.

Airports more conveniently located for city use and new high-speed streets from city business centers to airports, which is a part of the national highway program of the next 20 years, will stimulate the volume of short-distance plane travel.

The new four-engine planes, costing on the line $400,000, carrying 42 day-passengers, having 20 sleeper accommodations, and cruising at 219 mph, are in production. Fortunately progress in transport plane design is made step by step. If it came in leaps and bounds, expenditures of vast sums of money would be required to make necessary operating adjustments – quickly and adequately.

A development, of which we are on the threshold, is that of the express and freight airplane. Air express has made a rapid rise since 1930 notwithstanding high rates, and has multiplied 90 times in nine years. With express planes the tariff can be cut to half that of present rates in a reasonably short time.

A major reason for this possible reduction is that the internal arrangement of the transport fuselage can be simplified to reduce weight greatly. This is apparent from the following: In 1930 the transport plane carried approximately 25 lb per passenger as comfort facilities – upholstery, racks, and so on. By 1939 this comfort load was stepped up to 175 lb per passenger – by structures to overcome noise and vibration in the passenger compartment, increased floor area per passenger, by better seats, and so on. On a 21-passenger transport the elimination of these comforts would effect an economy of approximately 3500 lb that could largely be used for payload; hence the possible reductions in express tariff. Express ships will afford needed training facilities for pilots in blind landings. The cruising speed need not be so fast as on passenger transports with resulting fuel economy and increased tariff load.

Air passenger travel is making inroads on pullman travel: In 1935 it was 3.5% of pullman travel; in 1939 it was 7%; and estimates are that it will reach 10% in a few years.

An observation regarding the future relationship between the automobile and aviation industries may be pertinent. They are different industries, but there is much in common and, in the next 35 years, each is going to learn profitably from the other. The competition for travel patronage will dictate each cooperation. We are witnessing today a great bid by the railways to retain passenger travel and regain some that has been lost. The sacrilege of adding coaches to heretofore crack exclusive trains, with higher speed schedules and lower rates is one indication; but a more amazing one is the arranging for time payments for railroad fares and hotel accommodations. These moves presage the competition of tomorrow. It is most probable that a second-class passenger transport plane will be developed – one less luxurious, less speedy, but with maximum safety and economy.

The airline operators have studied, are studying, and must continue to study and apply all available economics in plane operation.

The high cost of a modern transport and its revenue-earning ability demand that it be kept in the air the greatest possible number of hours of the 24 per day until the engine overhaul, after 500 hours, is mandatory. Some efficient operators average 11 hours flying out of every 24 for the entire fleet, this includes planes being overhauled and repaired. An engine overhaul is accomplished in 4 to 10 hours. Operators are not satisfied but seek a design in which the engine as a complete unit can be replaced in perhaps 1 hour or less. They are demanding engine accessories that permit a minimum time for interchange.

These demands may be reaching into uncharted zones of design and assembly but, when competition demands them, they will be achieved.

Fuels

THE contribution made to automobile and aviation progress through cooperative research in fuels extending from 1921 up to the present, and the program of automobile and aviation engine improvement and development made possible by the fuel research, constitute one of the great forward steps of these industries.

This development took on active form with the formation of the Cooperative Fuel Research (CFR) program initiated in 1921. It had its inception in earlier individual and company researches in this country and abroad. Abroad it had been demonstrated that there existed a relationship between combustion characteristics of fuels and performance in engines. At home the results of antiknock tests were the subject of several years of study.

Fuel research, engine development,, and motor vehicle

revision made possible by such work, are activities that project themselves far into the next 35 years.

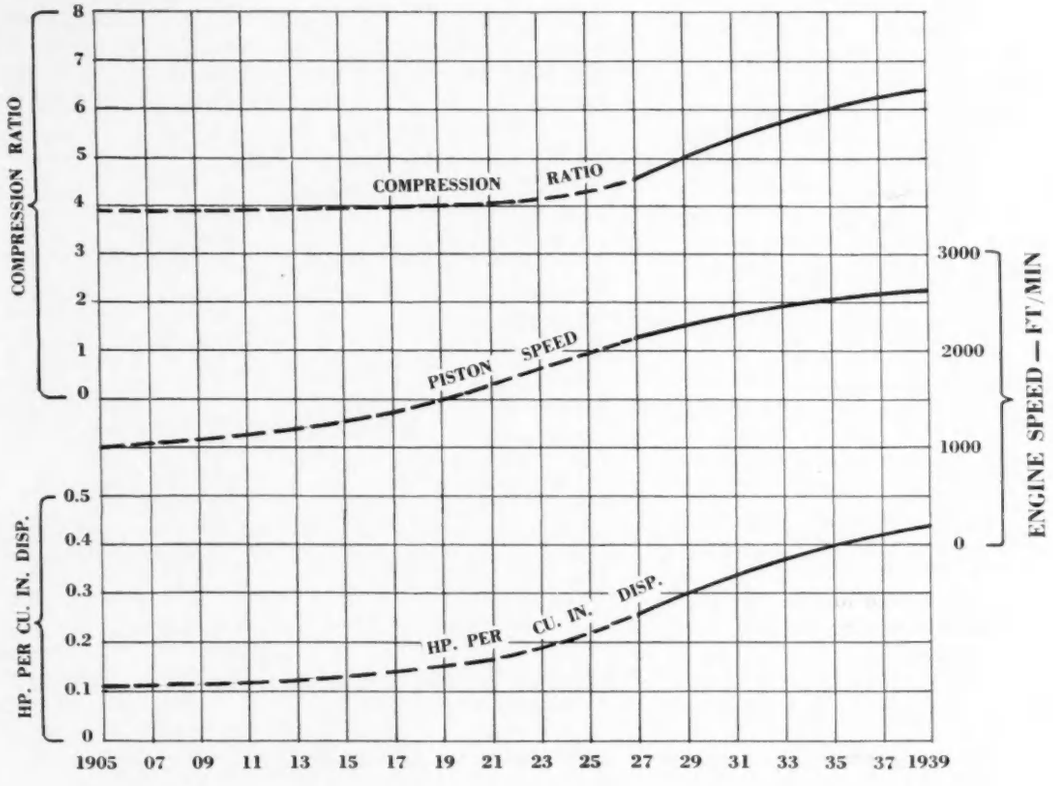
This cooperative program among fuel producers and motor-vehicle and aviation engineers merits conspicuous significance as it exemplifies the phenomenal accomplishments possible when there is whole-hearted and continuing cooperation among the parties concerned. Although the results of this cooperation are well known by the closely related and participating parties, the almost staggering proportions of the work already accomplished are not so widely realized as they should be.

ment has increased in one make of vehicle from 0.3 to 0.43 hp per cu in. and up, a power increase of over one-third.

Another manufacturer states that the average ton-mile per gal at 50 mph has increased from 22 to 31, a gain in basic economy of 41%.

Such results have not been accomplished without research, and what has this research been but work, more work and continuous work?

When this fuel development got actively under way, there were approximately 150 research engineers in the



Influences Arising Out of Fuel Research

To focus attention adequately on the work and results gained requires the staging of a joint meeting of all organizations that have contributed to the work to present qualitatively and quantitatively the gains reported – results of the outstanding automotive research of two decades.

The great advantage of the work has resulted from a commendable keeping in step by the fuel producers and the engine designers. As the fuel was improved, engine design was stepped up to use the new fuel efficiently, and higher vehicle speeds became the pace-setter for broad revisions of vehicle design. For a decade and a half there has been a continuous program of advancement.

Consider the record and see what have been the practical results of this cooperative work in the motor vehicle and airplane:

In 14 years, 1926 to 1940, top speeds of motor cars have stepped up from 55 to 85 mph and higher. In this same period octane ratings have risen from 55 to slightly over 70 in premium fuels.

The rise in octane ratings has made possible increasing the compression ratio from 5.1:1 to 6.7:1, which has been directly reflected in horsepower increase and performance.

Available horsepower per cubic inch of piston displace-

entire petroleum industry. By 1927 the number was 800; 1931 recorded 3000; and today it exceeds 5000.

The cost of such research has multiplied forty-fold:

This research has produced a 100% revolution in the refinery industry. Since the first use of the cracking process in 1913, when a yellowish pungent liquid known as motor spirits was produced by pressure distillation, research has increased the amount of gasoline from a gallon of crude from 21% to 45%, the present mark. Little further increase in the percentage of gasoline available from crude is expected. In fact, it has remained constant for nearly 10 years, because, since then, a new contender for its share of the crude has been the demand for household heating oil. Indications are that there will not be a larger percentage of the crude available for gasoline unless unexpected factors enter the field.

The evolution of the cracking process has worked a refinery plant revolution. Refineries have been completely rebuilt. The old processes and old equipment are gone. Old batch stills have given way to continuous pipe stills to which have been added new equipment for entirely new processes. Plant investment has more than doubled, and the revolution is just getting under way. Technically

trained men are in charge of every step in the refining process.

In this fuel evolution era that we are in the midst of, the motor vehicle will certainly receive an adequate gasoline supply, as the 30,000,000 vehicles consume 90% of all gasoline produced.

Since the initiation of the Cooperative Fuel Research, the motorist has not only seen the price of gasoline recede from 32c to 15c per gal, but he can purchase at every cross-road a fuel that gives uniformly good results during the twelve months of the year. The hectic days of the early 'twenties are no more. If gasoline taxes, which today represent a sales tax of 40% were removed, the reduction would appear in a truer light.

Octane rating is only one part of the story for hand-in-hand with higher octane ratings goes greater volatility which has enabled the engine designer to secure greater power. Thanks to the merchandising enterprise of fuel producers there is being marketed in the great central areas summer and winter fuels in which the mid-point volatility varies as much as 50%, which means maximum fuel economy the year 'round.

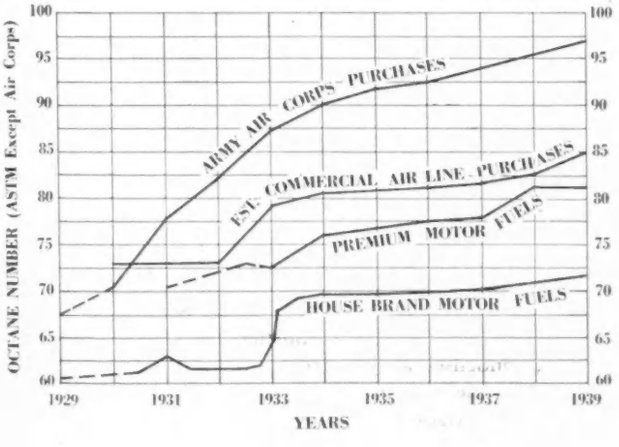
It is in aviation that still greater benefits have accrued, and immeasurably greater development made possible by the production of fuels of high-octane number as used in service planes. Here the effects of the new fuel have a marked bearing on the economics of plane operation as it means reduced fuel load, less engine weight for the same horsepower, less head resistance of plane, and other gains.

Now for the next 35 years:

An adequate supply of gasoline for the next 35 years seems assured as proved reserves of crude in the ground today are greater than ever known before. Improved methods of production have for 20 years resulted in a saving of more than 11 million barrels. By new methods, recovery of crude from sand areas has more than doubled. In some areas recovery has increased four-fold.

The production of gasoline by alkylation from refinery gas opens up a new, and it would appear a most extensive, field for increased production. This process is the reverse

10 Years of the Octane Number Race

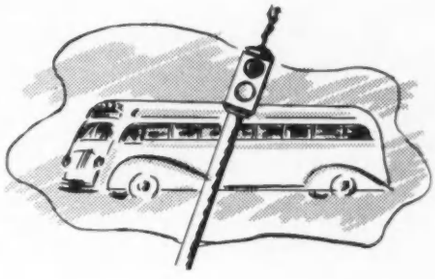


of cracking in that it starts with refinery gas and causes the small gas molecules to recombine into medium-sized ones suitable for gasoline. The volume of refinery gas available is large, being hundreds of times as large as the chemical industry can use. In fact, in the last 20 years, refinery gas, which was largely a neglected waste at refineries, has become an invaluable raw material for motor and aviation fuels.

Gasoline prices are definitely tied to the price of crude and, with new processes of production, it is very probable that the price will continue near the present level.

Octane ratings will continue to rise, and the 73 rating of today will approach 90 in premium motor fuels in the next decade and perhaps 80 for regular brands.

Buses



THE motor bus, which made its debut on Fifth Avenue in 1905, is celebrating its 35th anniversary. After years of growing pains, it has established itself as an accepted means of municipal transportation in 80% of our cities of 10,000 population. In 50% of such cities, it has displaced other means and today holds that field exclusively.

On our highways, bus service routes cover more than one-third of our total road mileage and the number of passengers carried annually would equal one trip a month for each of our 130,000,000 people.

These highway creations – expressive of power, speed, comfort and safety – have gained the confidence of the traveling public and have built around highway travel a spirit of romance which recalls the introduction of the horse coach of Shakespeare's time. Seeing the front doors of the countryside and urban centers while speeding on rubber over endless lanes of smooth pavement, with every consideration given to the comforts and requisites of travel, has won public fancy and laid a nation-wide foundation for permanent growth.

The achievements of great highway bus operators are signal examples of what men with vision can accomplish, paying dividends during the upbuilding process.

These operators have been pace setters for the manufacturers. They are style-conscious; they are of necessity business-conscious; they are passenger-conscious. They have been cooperative dictators to the manufacturers in the evolution of what are today the accepted designs for intercity and urban buses. They have created designs, they have dictated facilities, they have demanded performance – and, having obtained such ends through constructive cooperation with manufacturers, they are giving a service that exceeds public expectations.

Visualize one of these highway liners:

Its mechanical air-conditioning system, entirely automatic, can be set for desert or average road temperatures. Its lighting exceeds that of the modern railroad Pullman. Its baggage facilities meet the utmost requirements. Low-pressure tires afford the comfort of a passenger vehicle

and luxury seats with rubber cushioning bar criticism. Taking pages from airplane manufacture, the bus designer has made reductions of 1500 lb and more on a 40-passenger coach a reality. Erection of convenient terminals in cities and towns has established an atmosphere of permanency and convenience, and courteous operation and management have made the good will of the traveling public an enduring asset.

Examine the record as of today and from this speculate on the road for tomorrow:

As in the case of the automobile, the motor bus has been an evolution of 35 years and by 1975 the last stages will not have been reached.

Bus evolution has been more rapid than that of the passenger car. It has taken 35 years – a generation – to get the engine from front to the rear, and 54% of the 1939 output, excluding school buses, uses this location. The first step was in 1927, when a twin-engine design located the engines amidship below floor level. This afforded a level floor from front to rear and placed the driver in the most forward position available. A few buses using twin-engines similarly mounted were in use abroad in 1910, but proved uneconomic because lack of air-cleaners resulted in abnormal cylinder and piston ring wear due to dust.

The second step in the rearward engine movement placed a vertical design of engine on its side beneath the floor. A third step was the horizontal engine beneath the floor. The fourth step placed the vertical engine longitudinally at the rear; and the fifth mounted the vertical engine crosswise in the rear.

In 15 years motive power has increased from 4-cyl designs of 50 hp to 6-cyl designs of 175 hp, and passenger capacity has gone from 16 to 40 adults. Diesel engines have established themselves and the field of engine competition, diesel and spark ignition, may be definitely influenced by fuel developments. With power step-up, improved highways, higher speeds, and heavier loads came four-wheel brakes – air brakes in 1924, and vacuum later. Conservation of driver energy was an influential dictator in gearbox development which began with the selective set, continued with the addition of a fluid flywheel and went on to the latest step, the automatic type which has been demonstrating its feasibility during the past year. The miniature manual shift for selective gear sets merits mention as an energy conserver where the selective gearbox is used.

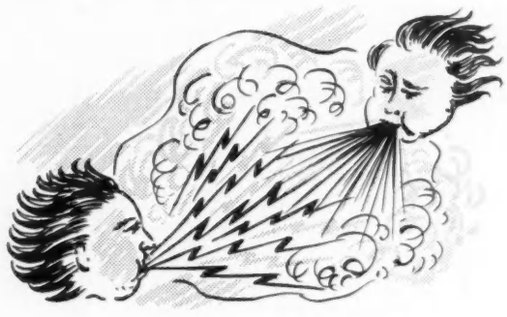
■ Bus Use Grows

Mass transportation by bus in metropolitan areas has years of growth ahead. The three-axle type of bus with center axle driver and front and rear-axle steering is on test. It equals the trolley in passenger capacity, has adequate interior mobility for passengers, and its maneuverability at intersections is under test.

Looking ahead, the best available ride is the one objective that must never be lost sight of – a ride that provides maximum passenger comfort whether the bus be partially or fully loaded. Such a ride may be attained by new designs of metal suspension or it is possible that rubber may offer a solution.

The fact that bus operations must pay their way indicates that years of evolution are ahead. The warning from Holy Writ, "Let him who thinketh he standeth, take heed lest he fall," is most timely. Railroad and airplane competition of a severe character is in the offing.

Air Conditioning



THE scope of and potentialities for increased motor transportation due to air conditioning – the baby in automotive evolution – constitute a chapter of untold and almost undetermined possibilities for expansion in motor transportation.

Its growth in motor bus operation in five years provides an indication of this. One of the largest bus operating companies now has 60% of its vehicles fitted with complete automatic air conditioning, the driver's sole responsibility being that of turning the switch to on, off, or to high or to low positions. The temperature variation within the bus compared with that outside varies with outside temperature. When the outside temperature is 90F that within the bus is between 71F and 74F, and where outside temperature is 110F that within is kept between 74F and 78F. For a 40-passenger vehicle a unit of 4-ton capacity is considered adequate.

Experimental bus operators in 1933 used 400 lb of natural ice per hour to provide some relief. In 1934 came the first motorcoach having a complete mechanical system. This early system was heavy, bulky and consumed passenger space, but in one year weight and bulk were reduced and no seating space utilized. Today in some current coach designs, the mechanical system is automatic in operation, as already mentioned, and most of it is located in baggage compartments or below floor level with the air distribution system incorporated in the roof. Such systems weigh approximately 1400 lb and the cost per vehicle ranges from $1800 to $2900 installed, a portion of the cost being due to fancy trims and fixtures. Such systems operate at a cost of approximately ¼¢ per mile, this including maintenance and annual overhaul.

The blower system with capacity for 1200 cu ft of air per min, draws one-third of this supply, filtered and electrically deodorized, from outside the body compartment. This system provides a complete change of air every three minutes.

The bus air conditioning system as used today incorporates its own internal combustion engine, compressor, radiator, condenser and controls, and no parasitic load is imposed on the engine of the coach other than that of weight transportation. Electric current for igniting the refrigerating engine and operating the blower motor is drawn from the bus storage battery. The refrigerating engine is entirely automatic, starting and stopping with cooling demands, and is protected by thermostatic controls in case of any mishap in the system.

Motorcoach air conditioning has many problems ahead

because of the wide variation of body constructions that affect heat losses. Coaches for Southern areas have had very limited body insulation whereas those for snow belt zones have been more adequately insulated. This variation has demanded over-capacity cooling equipment. Improvement in body construction will measurably alter the design and type of equipment as years pass.

The bus is but one division of the refrigeration field in motoring. Already its use in highway merchandise transports has gained momentum and its future is seemingly limitless.

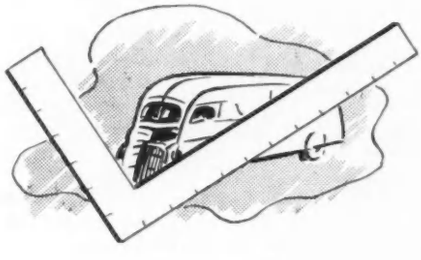
What is known as the self-contained unit system has made greatest progress. This system consists of a unit which is complete with engine, compressor fuel supply, refrigerant system and controls. Its operation has no relation to any chassis mechanism – a paramount consideration when installed in semi-trailers, trailers, or other detached vehicles.

The effectiveness of the self-contained unit system in the transportation of meat and dairy products, where temperatures in the middle thirties are maintained, has been proven today. Demand is now at hand for units that will provide the much lower temperatures required in the distribution of frosted foods.

These units are carried within the insulated vehicle body, with a side door for regulation, inspection or exchange of units. The near future will witness quite revolutionary growth in this field.

It is a matter for congratulation that some of the leaders in providing refrigeration and air conditioning components are old established firms in the motor component and equipment industry, and that they are bringing to this new product the best in engineering and manufacturing art. This augurs well for constructive evolution, economical manufacture, and continued research. This activity also broadens the base of such concerns.

Motor Trucks



A REALIZATION of the commercial possibilities of the motor truck began with the electric vehicle at the turn of the century. A few such electric vehicles have been in continuous operation for nearly 40 years. Attention had turned to the gasoline type when the SAE came into being and, up to 1912, the numbers registered virtually doubled each year. For the next dozen years the increase approximated 50% annually and, for the past 15 years, there have been annual increases ranging from 3% to 10%.

For the first decade of its development the motor truck was used largely as a horse-vehicle substitute but, during these years, a conception of what increased motor-vehicle speeds, as compared with horse pace, would mean in larger distribution areas, was beginning to be realized. In 1911, the first paper on the science of motor-truck operation was presented before the Society, and the subject of standards for capacities was discussed. That paper represented the start of the science of economic motor-truck transportation.

By 1915 experiments were under way for adapting pneumatic tires to trucks, but it was in the late 'twenties before they were in general use. The influence of the pneumatic tire on production was evident in the middle 'thirties after the first effects of the depression were easing, and annual production increased for four years by over 100,000 vehicles each year. The economic value of the truck in the revamping business became apparent.

One example may serve to indicate the changes in commodity distribution made possible by truck transportation: A national meat-packing house expanded its delivery from warehouses from a 15-mile radius to a radius of 150 to 200 miles, thereby eliminating many distribution centers. The change in meat retailing precipitated new problems of increased service from one delivery to a retail store per week to as many as two deliveries per day. One result of this change was that, while the average payload in 1925 was 3.5 tons, today it is 1.25 tons. In place of the long range of truck capacities, this company needs today but two classes – heavy and light. The use of large-capacity vehicles will decline as more favorable freight rates on railroads are obtained.

Another example of the movement toward use of smaller-capacity vehicles is a large utility company that formerly used 5-ton vehicles with a crew of 15 men, but is today using 1.5-tonners with a five-man crew plus a supply of truck-operated power equipment, which has made possible the reduction in the crew. Here again, the demand for frequent and quick service by the public has been the reason for the change.

Many more examples of this demand of public for quick service could be cited. It typifies the requirements of the present age and is certain to continue.

For years the Transportation and Maintenance Activity of our Society has carried out constructive studies relating to truck design from the operators' viewpoint, and it has seemed at times that manufacturers have not given as much consideration to these presentations as they warranted. As research and manufacture have effectuated the closest cooperation in the past 15 years to their mutual advantage, so should truck makers and the large fleet operators cooperate. Here are presented a few examples that suggest the necessity for such cooperation:

The present trend toward too much style and inadequate visibility and comfort is costing the operator money. A study of 15 most frequently performed shop operations on different makes of light-capacity trucks in which 1930 and 1939 models reveals that, on one make the time required increased 32% from 1930 to 1939; on another, the time increase was 27%; and on the other, 34%. From 1930 to 1939 these vehicles have improved to where the jobs do not require the same frequency of repair, but designers have failed to consolidate the gains made by improved designs and better materials. Greater accessibility of wearing parts is asked for. Due to higher operating speeds and greater distances covered, the number of inspections and repairs during the life of the truck remains about the same, but hourly wages of repair men are up.

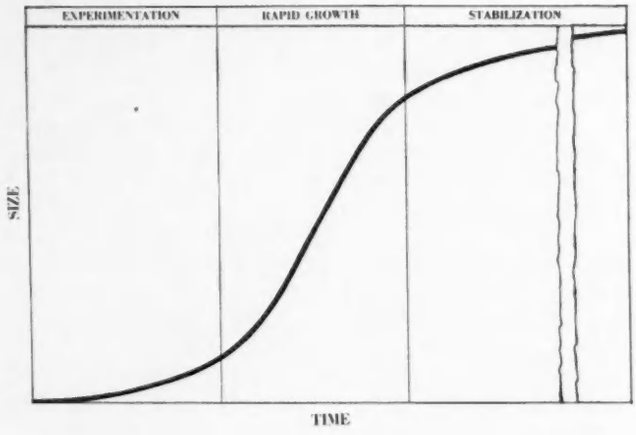
Better spring suspension and easier operation by the driver, much discussed by operators, are sufficient intimations of some paths of improvement. The increased speeds

of today demand a suspension system that provides adequate control and an easy ride in the range from no load to full load.

It is certain that, within the next few years, regulatory authorities in their programs for greater safety will conduct studies connected with safety of operation under all conditions of loading. A test of brakes on vehicles operating under Interstate Commerce Commission regulations will be conducted in 16 states this summer. The ability of loaded vehicles to make maximum stops from speeds of 50 mph down with adequate driver control, is a subject at present under consideration. With the recent extension of Interstate Commerce Commission regulation over private carriers operating in interstate service, such carriers will be subject to Federal regulations prescribing standards of equipment and standards of brake performance.

It seems most apparent that a regime of closer cooperation between manufacturers and at least large fleet operators is imperative if extensions of government regulation are to be avoided. The industry and its users should put their own house in order.

Typical Industry Growth Curve



■ Acknowledgment

To the following companies, publications, and associations, the author extends his sincere appreciation for helpful information, advice and comment:

Air Transport Association of America, American Petroleum Institute, American Telephone & Telegraph Co., Armour & Co., *Aviation,* Baker Ice Machine Co., Bendix Products Division of Bendix Aviation Corp., Bendix-Westinghouse Automotive Air Brake Co., *Bus Transportation,* Civil Aeronautics Authority, *Commercial Car Journal,* Eastern Airways, Firestone Tire and Rubber Co., General Motors Corp., General Motors Truck & Coach Division of Yellow Truck & Coach Mfg. Co., Greyhound Bus Lines, *Motor,* Motor Wheel Corp., National Advisory Committee for Aeronautics, National Highway Users Conference, National Industrial Conference Board, Norma-Hoffmann Bearings Corp., Packard Motor Car Co., Pan American Petroleum and Transport Co., Perfect Circle Co., Phillips Petroleum Co., Pratt & Whitney Aircraft, Public Roads Administration, A. Schrader's Son, Division of Scovill Mfg. Co., Inc., Timken-Detroit Axle Co., *Tires,* The Torrington Co., Twin Coach Co., Waukesha Motor Co., Wright Aeronautical Corp., Young Radiator Co.

About Authors

(*Concluded from page 15*)

ing his studies in mechanical engineering at the University of Illinois. He then entered the automotive industry as test driver at the Packard proving grounds; later transferring to the final car-inspection department. Two years ago he began working in the trim engineering department, where he is assigned to follow seat-cushion and backspring design.

■ **Clyde R. Paton** *(M '23), 1938 SAE vice president representing the Passenger Car Activity, a past chairman of the Detroit Section, and a member of several SAE committees, started in the automotive industry as manager of a garage in his home town, Almont, Mich. He later managed the Paton Electric Service Co., until he enlisted in the U. S. Army Air Service in 1918. Following the war, he was student assistant in mechanical engineering at the U. of Michigan, was assistant mechanical engineer with the NACA, and an engineer in the Studebaker research department. In 1930 he joined Packard as experimental engineer and in 1932 was advanced to chief engineer. Mr. Paton holds many patents on automotive designs.*

■ **E. C. Pickard** *has been doing trim work since the horse and buggy days. Educated in public schools of Ann Arbor and Detroit, he studied mechanical drawing at Detroit night schools, and graduated in factory management from the Lincoln Extension University. Mr. Pickard has worked in most of the important automobile trim shops and for the past six years has been trim engineer at the Packard Motor Car Co.*

■ *Since 1934* **Clarence H. Wiegman** *has been in the engineering department of Lycoming Manufacturing Co. He started as designer on large liquid-cooled aircraft engines, and in 1936 was promoted to project engineer in charge of air-cooled engines, covering Army and commercial radials, and design and development of 50 to 75-hp light, direct-drive and geared aircraft engines. Mr. Wiegman was a member of the Packard engineering department from 1920 to 1934. During this period he was engaged in layout and design work on Packard models 1500 and 2500 12-cyl. water-cooled, aircraft engines; 24-cyl X racing-aircraft engine; Packard diesel aircraft engine; and did special design research work under the late Capt. L. M. Woolson. He received his engineering education at the Detroit Institute of Technology, Detroit City College, and the University of Detroit, completing some of his studies while working at Packard.*

■ **Wayne H. Worthington** *(M '17) graduated from Oklahoma A & M in the days when farm power was represented by the awesome steam traction engine operated by the custom thresher man. Following a brief interlude as oiler on the Mallory Liner "Brazos," he entered the foreign service of the J. I. Case Co., and worked for five years in Russia and three in Argentina as field engineer. Returning to the U. S. A., Mr. Worthington joined the Aultman & Taylor Machinery Co., and later became chief engineer, and chief engineer and director of engineering of their successor, the Advance Rumely Co. For the past ten years he has been with the John Deere Tractor Co. as research engineer in charge of new design of a full line of agricultural tractors and industrial engines.*

35th Anniversary

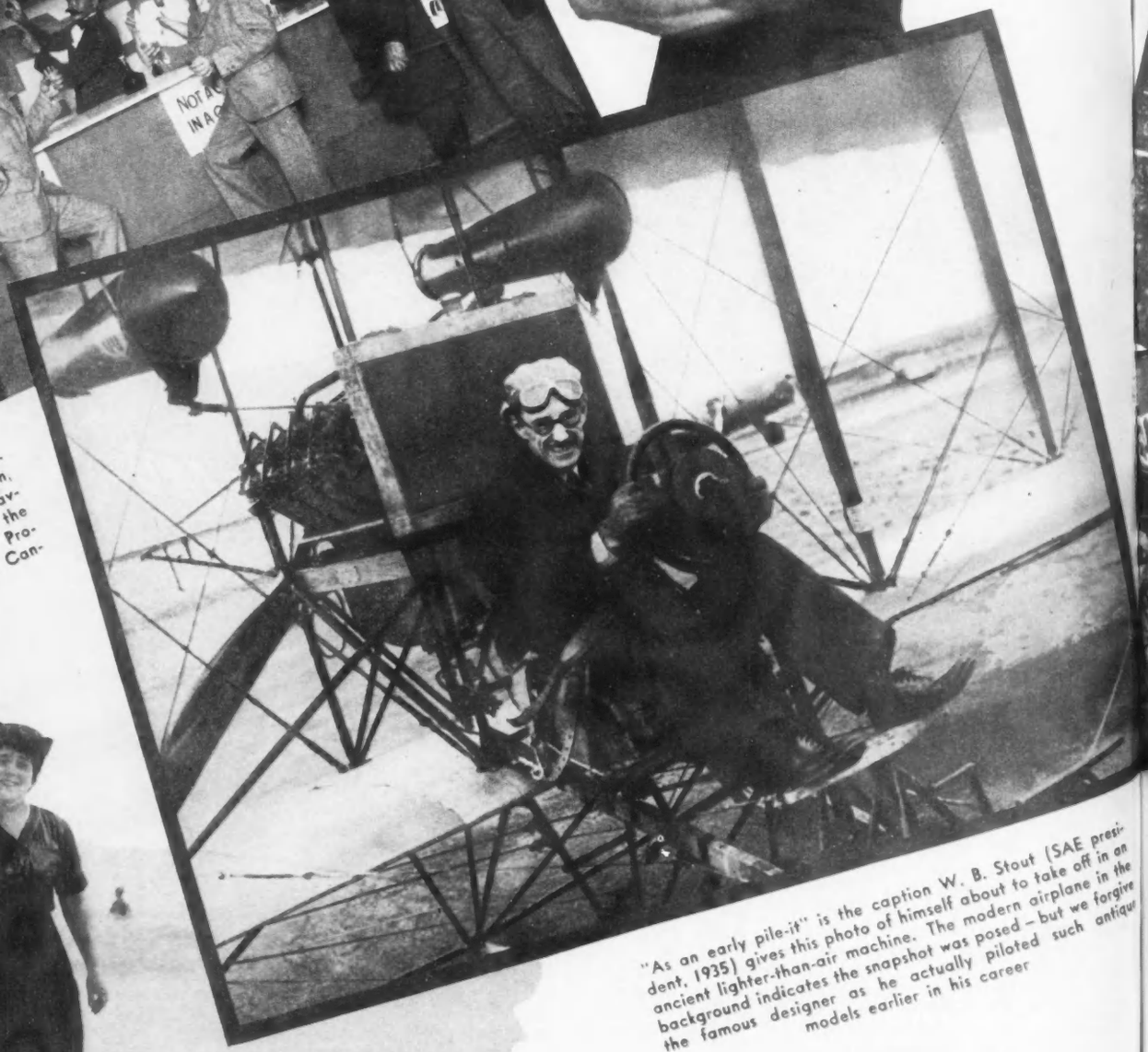
of the Society of Automotive Engineers

Remember When?

HERE'S HOW!

"Well for Chrysler Six!" Messrs. Cumming, Risley, Coleman, and Lemon at the "Wife Saving Station" bar set-up for the 1928 Summer Meeting. Prohibition, as observed in Canada (Quebec)

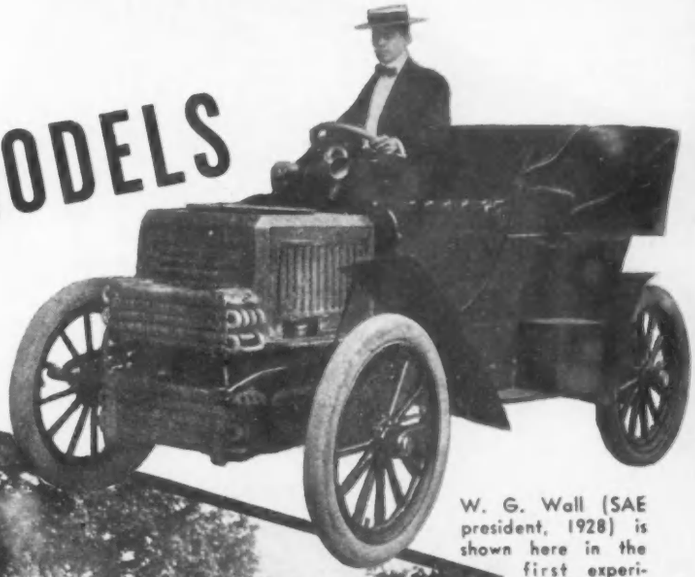
His tribe sold Sta
Island to the white
for $24. In 1923 he t
to collect the sales
When he returned to
SAE Summer Meeting
had nothing left but
bathing suit (Spring L
Section stunt)



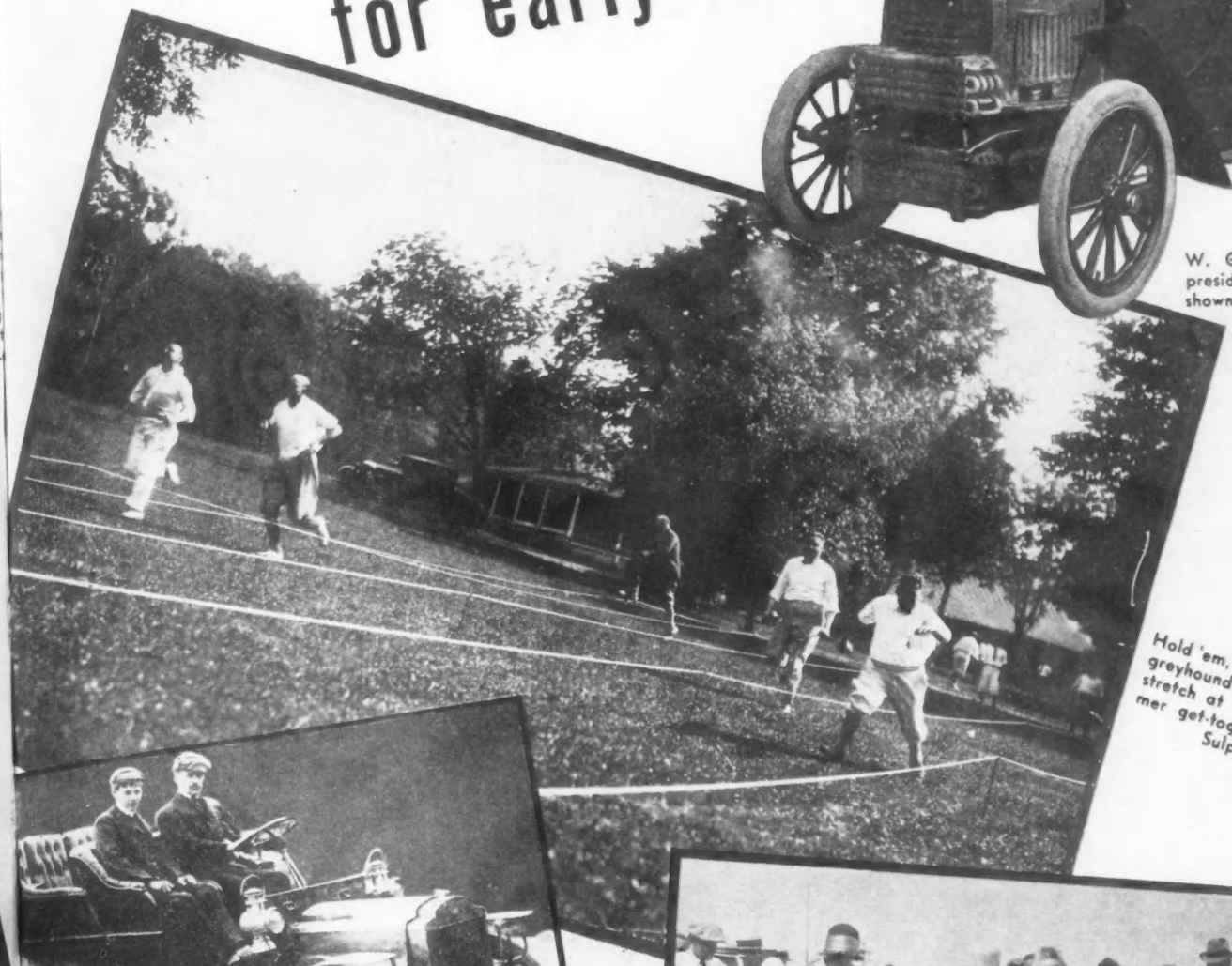
"As an early pile-it" is the caption W. B. Stout (SAE president, 1935) gives this photo of himself about to take off in an ancient lighter-than-air machine. The modern airplane in the background indicates the snapshot was posed – but we forgive the famous designer as he actually piloted such antiques models earlier in his career

Jeepers, creepers! Alfred Reeves and company engage in surf bathing – 1914 style (Cape May)

TORTURE-TESTS for early MODELS



W. G. Wall (SAE president, 1928) is shown here in the first experimental car he designed and built for the National Car Co. – 1902



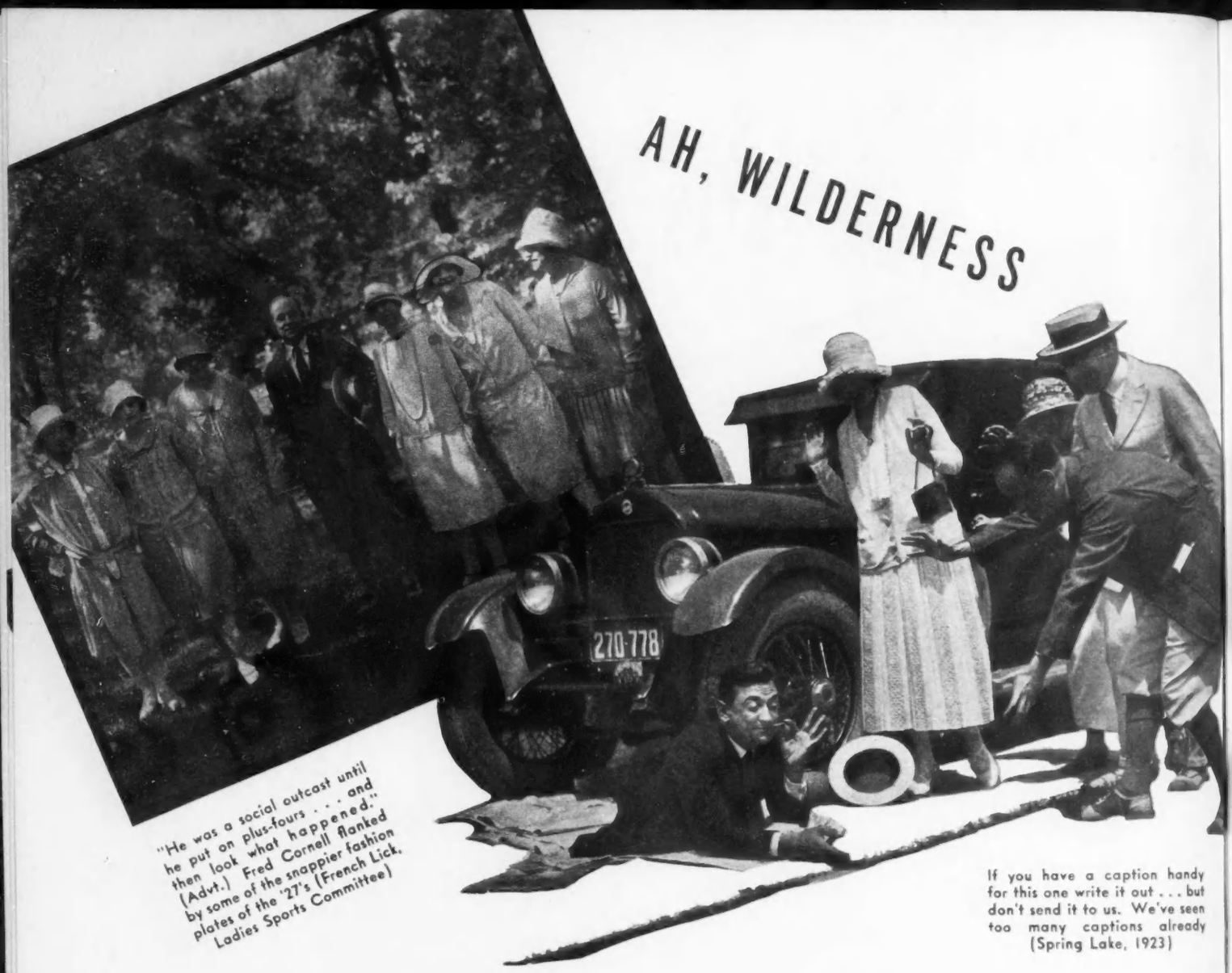
Hold 'em, Buckwalter! SAE greyhounds lope down the stretch at the 1925 Summer get-together (White Sulphur)

The first "climb to the clouds" on Mt. Washington – 1904. Warren Pratt and H. W. Alden (SAE president, 1912 and 1923) pose in their 4-cyl Columbia car, the first of its kind

Hold your hats, boys, the girls are loose again! The engineers' wives give an imitation of the road action of the '24 cars (Spring Lake)

Henry Souther and friends went rowing the first day of the 1914 Summer Meeting. A week later, when this photo was snapped, they had not quite reached the surf. Persistent fellows, aren't they? (Cape May)

AH, WILDERNESS



"He was a social outcast until he put on plus-fours . . . and then look what happened." (Advt.) Fred Cornell flanked by some of the snappier fashion plates of the '27's (French Lick, Ladies Sports Committee)

If you have a caption handy for this one write it out . . . but don't send it to us. We've seen too many captions already (Spring Lake, 1923)

AIR-VIEWS

Human SAE. It was an engineering feat to get some 500 SAE members in position at the exact moment the aerial camera plane reached the field. Positive photos were developed in the air by a new process just developed for the U. S. Army and parachuted to the ground as the formation broke up (French Lick, 1926)

E. P. Warner (SAE president, 1930) prepares to fly a 1926 military plane shortly after taking office as the Assistant Secretary of the Navy for aeronautics

ASK THE MAN WHO OWNS ONE

One of the earlier 2-mule-power models. Economic, durable, guaranteed to start in all kinds of weather. H. C. Dickinson on his presidential tour – 1933

The White Steam Car looked like this back in 1903. If you had asked A. J. Scaife (SAE president, 1932) or Bert Adams (pictured at left) how they felt about this particular model they would have probably said it represented the ultimate in automotive design, performance and comfort

THE WITCHING HOUR!

Cute Pranks-of-Parents department. F. E. Moskovics and friends clown on the sands of Cape May at the 1914 Summer Meeting

Riding a life-boat carrier was the last word in 1914 deviltry. Here are a group of SAE business. Here are a group of glamour girls and playboys running amuck on the beach of Cape May

SCENES FROM an SAE FOUR-BELL PRODUCTION . . .

One of the reasons why vaudeville went out. Some 1913 Summer Meeting rogues portray "I love my wife, but Oh, you kid!" (Sault Ste. Marie)

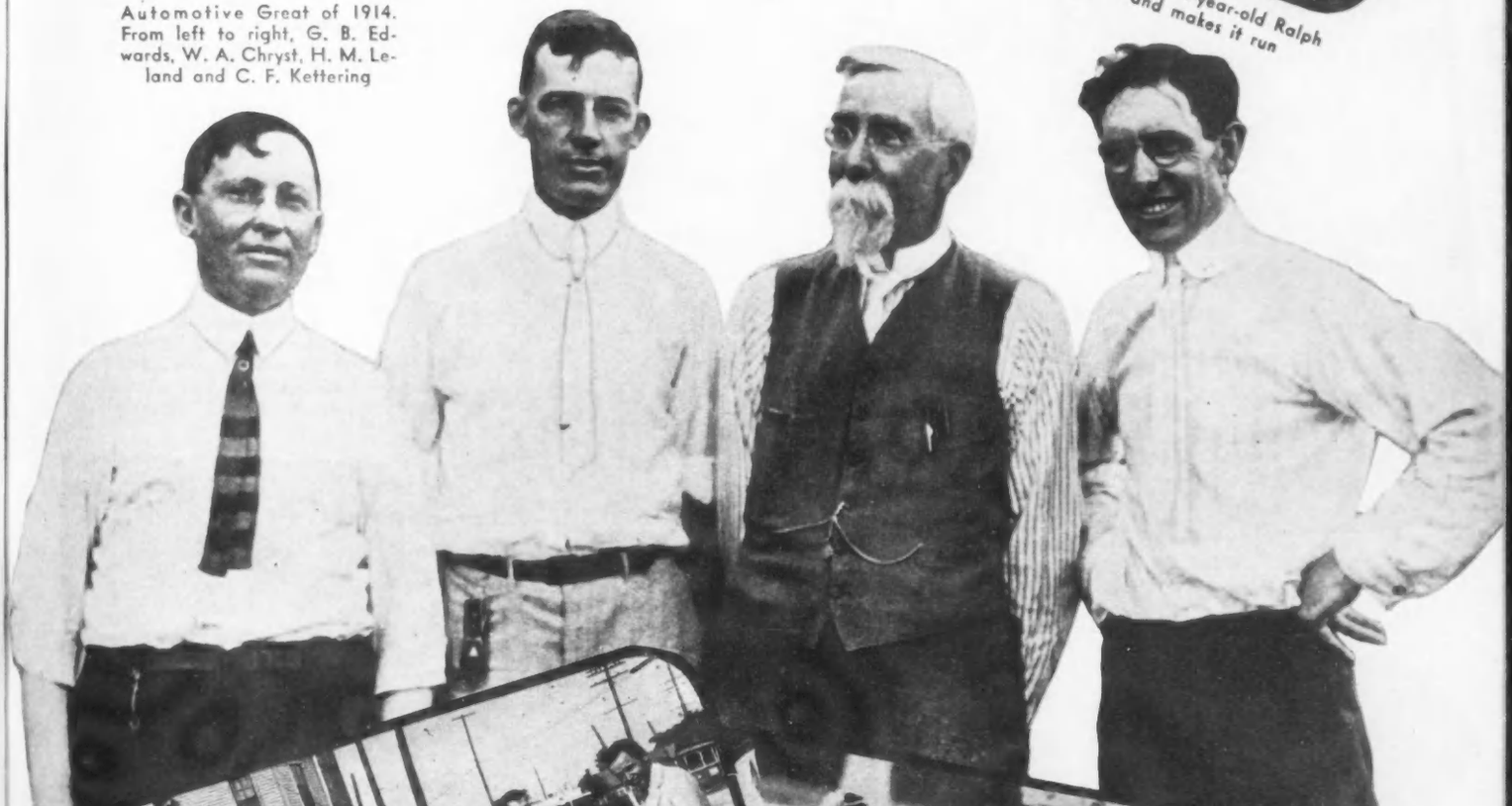
Lawd, Boys, won't you ever let up! (Sault Ste. Marie)

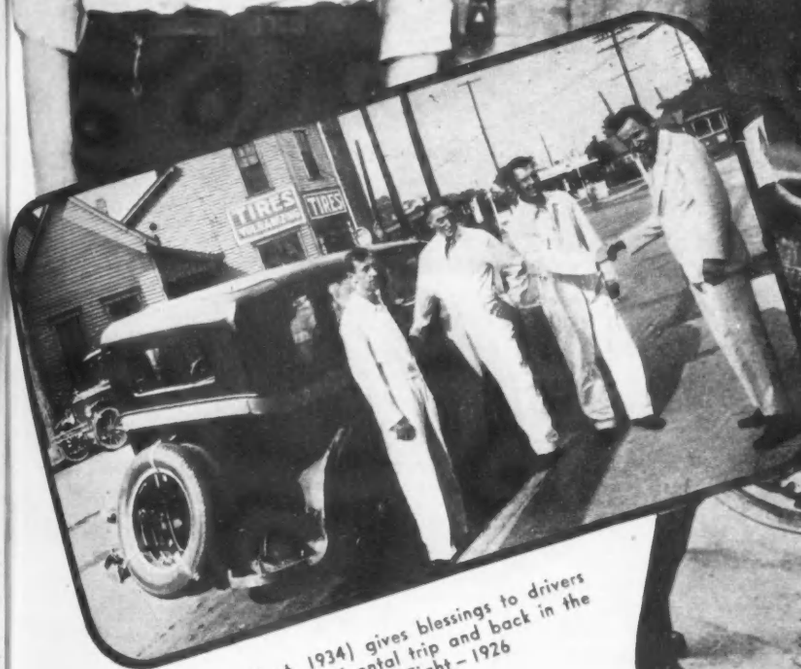
The 1913 Ritz Brothers. Confucius would have had something to say about that kimono. Now you can see why that 1913 Summer Meeting was just the rip-roarinest little ol' meetin' there ever was (Sault Ste. Marie)

. . . and other TINTYPES

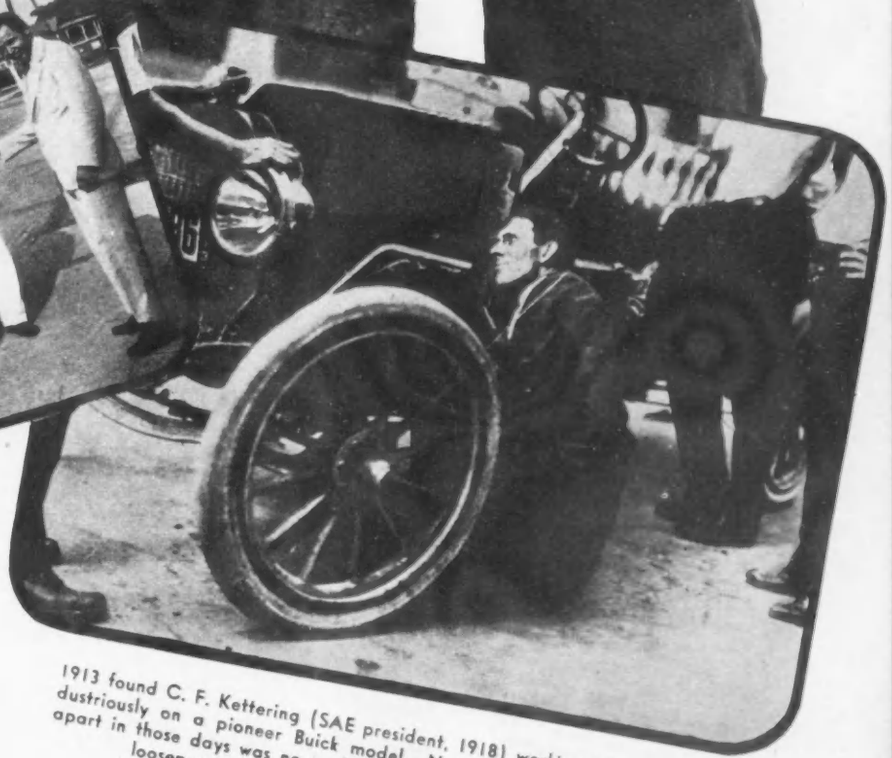
An amazing accomplishment in 1902! Thirteen-year-old Ralph Teetor builds his own automobile – and makes it run

Automotive Great of 1914. From left to right, G. B. Edwards, W. A. Chryst, H. M. Leland and C. F. Kettering





D. G. Roos (SAE president, 1934) gives blessings to drivers about to embark on a transcontinental trip and back in the first small Marmon Straight Eight – 1926



1913 found C. F. Kettering (SAE president, 1918) working industriously on a pioneer Buick model. Note: Taking a car apart in those days was no problem – all you had to do was loosen one or two bolts and then leap aside

TECHNICAL TOPICS

TURRET TOPS

Under those hats, reading from left to right, are Mrs. Dusenberg, Louis Chevrolet and Mrs. Chevrolet. Head fashions certainly have changed since 1926 (French Lick)

CHASSIS ASSEMBLING

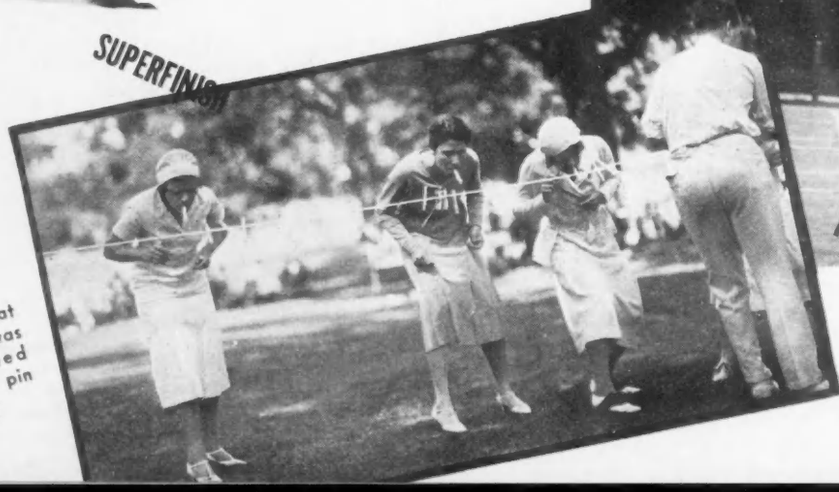
Here's a snappy parlor game for dull evenings. At the 1927 SAE Summer Meeting the first intersection chassis-assembling contest was held (French Lick)

INDEPENDENT SPRINGING

Standing broad jump, 1925 Summer Meeting, featured knee-breeches and strained torsos

ANTIKNOCKS

History in the making. Midgley demonstrates his antiknock fluid before a prominent '23 Summer Meeting group (Spring Lake)



SUPERFINISH

FREE-WHEELING

Women's tennis at 1929 Summer Meeting consisted of (a) holding racket (b) holding skirts (c) holding hat and (d) holding breath (Saranac)

Mother never hung clothes that way . . . but then mother was never one for new-fangled methods. A 1931 clothes pin race (White Sulphur)

About SAE Members

The board of directors of American Brake Shoe & Foundry Co. recently appointed **W. A. BLUME** president of the American Brakeblok Division. Mr. Blume has been affiliated with the company since 1915 and conducted its early experiments on automotive brake lining. In 1926 he was appointed vice president of the division in charge of production and engineering, the position he held at the time of his appointment to the presidency.

PIERRE S. du PONT, who recently retired as chairman of the board of directors of E. I. du Pont de Nemours & Co., will continue on the board and as a member of the company's finance committee.

On June 1, when General Motors Corp. acquired the assets of Engineering Projects, Inc., Dayton airplane propeller manufacturers, and established the Aeroproducts Division of General Motors Corp., **WERNER J. BLANCHARD,** president of Engineering Projects, became general manager of the new division. The new division will continue propeller development which has been conducted by the acquired company. Previous to organizing Engineering Products, Inc. Mr. Blanchard was an engineer with the Curtiss-Wright Corp., in charge of propeller development.

DR. GEORGE GRANGER BROWN, professor of chemical engineering, University of Michigan, recently was presented with the E. I. Hanlon Award for meritorious service

Dr. George Granger Brown
Honored

and accomplishments in the field of natural gasoline. The award is presented each year at the annual convention of the Natural Gasoline Association of America. Dr. Brown presented the paper, "Measurement of Gas Flow Under High Pressure," at one of the convention's technical sessions. **R. C. ALDEN,** director of research, Phillips Petroleum Co., also participated in the program, presenting the paper, "Neo-Hexane, the Fuel of Tomorrow."

L. H. POMEROY is a director of H. M. Hobson (Aircraft & Motor) Components, Ltd., Coventry, England.

HOY STEVENS, treasurer and sales manager, Inspection Machinery Co., Cleveland, is the author of a series of articles on "Engineering & War" appearing in *Cleveland Engineering*, published by the Cleveland Engineering Society.

WILLIAM B. STOUT, president, Stout Engineering Laboratories, has developed a method of fabricating aircraft structures from thin-gage stainless steel which is aimed at placing manufacture of aircraft fuselages on the same production basis as employed in automobile sheet-metal fabrication. Plans are under way to incorporate a new company that will function to license production and methods patents to aircraft manufacturers.

GM Acting President

Charles E. Wilson

CHARLES E. WILSON, executive vice president, General Motors Corp., has been named acting president of the corporation to serve during the leave of absence granted to **WILLIAM S. KNUDSEN,** president, who has been released to become production coordinator of the government's Advisory National Defense Committee. Mr. Wilson, who became executive vice president in May of last year, has been an executive in various capacities with the corporation and its subsidiaries for more than 20 years.

JAMES D. MOONEY, Geneal Motors vice president in charge of overseas operations, New York, has been relieved of his responsibilities in this connection and

James D. Mooney
Executive Assistant

transferred to Detroit as executive assistant to Mr. Wilson, in full charge of all negotiations involving defense equipment and with such liaison activities as may be necessary in connection with engineering and production.

CHARLES B. BOHN, heretofore president of the Bohn Aluminum & Brass Corp., was elected chairman of the board of direc-

Charles B. Bohn
Elected Chairman

tors at a recent meeting of that group. At the same meeting **EMERSON FRANTZ,** former general sales manager, was elected vice president in charge of sales.

A. T. COLWELL, vice president, Thompson Products, Inc., has been elected to succeed **DR. GEORGE W. LEWIS,** director, aeronautical research, National Advisory Committee for Aeronautics, as an SAE representative on the Daniel Guggenheim Medal Board of Award. Other SAE representatives, whose terms continue, are **G. J. MEAD,** vice chairman, National Advisory Committee for Aeronautics, recently appointed special assistant to the Secretary of the Treasury, and **F. W. CALDWELL,** engineering manager, Hamilton Standard Propellers. **R. F. GAGG,** assistant chief engineer, Wright Aeronautical Corp., has been named a representative of the American Society of Mechanical Engineers, to succeed **WILLIAM B. MAYO. ELMER A. SPERRY, JR.,** is chairman of the Board of Award, and **ALEXANDER KLEMIN,** secretary.

BERNARD D. CLAFFEY, manager, grey iron and aluminum division, General Malleable Corp., Waukesha, Wis., has been elected a member of the American Foundrymen's Association's board of directors.

COL. EDWIN E. ALDRIN, aviation consultant, has become actively associated with the Aro Aircraft Division of the Aro Equipment Co., Bryan, Ohio. Col. Aldrin has assisted in establishing the division, and his entire attention now will be given to further developing the sales and service organization. He is a lieutenant-colonel and pilot in the reserve attached to the United States Army Air Corps, was formerly assistant executive officer at Wright Field, and at one time was chief of the Airplane Section Materiel Division. Col. Aldrin resigned from the regular army in 1928 to organize the aviation interests of the Standard Oil Co. and its affiliates. His headquarters will continue in New York.

H. K. INTEMANN, formerly in charge of engineering, Halowax Corp., unit of Union Carbide & Carbon Corp., has become sales manager of the same company.

OLIVER H. COTÉ, JR., who was junior engineer at the Naval Aircraft Factory, Philadelphia, has been promoted to assistant aeronautical engineer and transferred to the Structures Section, Bureau of Aero-

nautics, United States Navy Department, Washington.

A. H. D'ARCAMBAL, consulting metallurgist, Pratt & Whitney Corp., forecast large-scale substitution of molybdenum for tungsten in the production of high-speed tools, due to the war-created shortage of tungsten, in addressing the May meeting of the New York-New Jersey Chapter, American Society of Tool Engineers. Mr. D'Arcambal is president of the ASTE.

DAVID A. WALLACE, president, Chrysler Sales Division, Chrysler Corp., who was not content to be chauffeur-driven while recuperating from a broken leg suffered in an accident last winter, devised a "one-legged" car that can be operated by a single pedal combining clutch and brake, functioning in conjunction with a fluid drive.

J. HODGES PARKER, formerly automotive maintenance supervisor, Virginia Electric & Power Co., Norfolk, has joined the Carnegie-Illinois Steel Corp., Duquesne, Pa., as industrial engineer.

JOHN G. LEE, assistant director of research, United Aircraft Corp., has been appointed to the personnel committee of the board of governors, Hillyer Junior College.

RICHARD G. McELWEE, Vanadium Corp. of America, has been placed in charge of a newly created foundry unit in Detroit. He has been connected with the Vanadium Corp. since 1936 as foundry engineer and consultant. Previously he was with the Ecorse Foundry Co., Ecorse, Mich.

Committee Personnel Changes

L. A. DANSE, Cadillac Motor Car Division, General Motors Corp., formerly a consulting member of the Iron & Steel Division of the SAE Standards Committee, has been named a regular member of the division. **J. H. JONES,** Republic Steel Corp., has been named to the division as a representative of his company. Republic Steel formerly was represented by **NORMAN L. DEUBLE,** who is now with the Copperweld Steel Co. He is retaining his membership on the division.

To the Aircraft Division of the Standards Committee have been appointed: **HENRY GLEDHILL, JR.,** Douglas Aircraft Co.; **A. C. FALK,** Kellett Autogiro Co.; **C. E. WINGATE,** Vought-Sikorsky Aircraft; **L. P. WOOD,** Stinson Aircraft Division, Aviation Mfg. Corp.; and **DAVID MENDENHAL,** Harlow Engineering Corp.

DR. F. L. MILLER, Standard Oil Development Co., has been named to succeed **GEORGE M. MAVERICK,** of the same company, on the Lubricants Division of the Standards Committee and several of its subdivisions.

J. E. PADGETT, Spicer Mfg. Corp., has been appointed to fill the vacancy left by the late C. W. Spicer as one of the five SAE representatives on the ASA Sectional Committee on Small Tools and Machine-Tool Elements.

ROBERT WUERFEL, Chevrolet, has been appointed to the SAE Motor Truck Rating Committee.

CHARLES ANKLAM, C. M. Hall Lamp Co.; **R. N. FALGE,** Guide Lamp Division, General Motors Corp.; and **W. F. LITTLE,** Electrical Testing Laboratories, have been appointed to represent the Society on the Standing Committee on Standards for After-Market Lamps and Signal Equipment, organized by the United States Bureau of Standards.

STANLEY B. SMITH, formerly automotive engineer, Heyer Products Co., Inc., Belleville, N. J., is project engineer, Stromberg aircraft carburetor department, Bendix Aviation Corp., Mishawaka, Ind.

GEORGE H. SCHOENBAUM, heretofore engineering representative of the Esso Marketers for Government services, located in Washington, has been transferred to the Detroit Area where he will take up duties as engineering representative for the Standard Oil Co. of N. J. interests.

A. H. WEBBER, district sales manager, The Perfect Circle Co., who was located in Beverly Hills, Calif., now makes his headquarters in Kansas City, Mo.

ANKER K. ANTONSEN is chief engineer, diesel division, Menasco Mfg. Co., Los Angeles, Calif. He previously was senior engineer, John Deere Tractor Co., Waterloo, Iowa.

ALEX TAUB, power unit engineer, Vauxhall Motors, Ltd., Bedfordshire, England, and CAPT. NORMAN F. STOCKBRIDGE, AC-Sphinx Spark Plug, Ltd., Bedfordshire, recently were elected to the Council of the Institution of Automobile

Alex Taub
On I.A.E. Council

Engineers. In announcing the elections, the Institution's May Journal says of Mr. Taub: "He is well known throughout the industry, not only for his researches into automobile engineering problems, but also for his *obiter dicta* which combine wisdom with edification. As he served on the Council of the SAE for several years whilst in the U. S. A., he may be regarded as having long passed his novitiate and will take his seat as an experienced Councilor." Capt. Stockbridge has represented his firm on The Automobile Research Committee on the IAE Council for a number of years, in addition to having been a Corporate Member since 1929, so that he is fully in touch with the work of the Institution in its various aspects.

FREDERICK G. HUGHES has been reelected president of the Manufacturers Association of Hartford County, Conn. Mr. Hughes is general manager of New Departure, Division of General Motors, Bristol, Conn.

H. C. M. STEVENS, general manager, Avimo, Ltd., manufacturers of aeronautical equipment, Taunton, Somerset, England, has been elected a Fellow of the Royal Aeronautical Society.

W. C. LAWLER, formerly sales engineer, Southwest Grease & Oil Co., Wichita, Kan., is with the Midwest Oil Co., Sioux Falls, S. D.

CAPT. ARTHUR B. NICHOLSON, Coast Artillery Corps, United States Army, formerly stationed at Fort Monroe, Va., has been transferred to Mitchel Field, Hempstead, N. Y., where he is adjutant, Air Defense Command.

The appointment of **CHARLES J. McCARTHY** as general manager of the Vought-Sikorsky Aircraft, Division of United Aircraft Corp., recently was announced by

Charles J. McCarthy
General Manager

United Aircraft's president, **EUGENE E. WILSON.** Mr. McCarthy joined Chance Vought Aircraft as executive engineer in 1926, was made chief engineer in 1930, and became engineering manager in 1935. In 1937 he was appointed assistant general manager, retaining this position when the Chance Vought and Sikorsky divisions were consolidated to become the Vought-Sikorsky Aircraft division in 1939. From 1916 to 1926 he served with the Navy and now holds the rank of lieutenant-commander in the Naval Reserves.

RALPH S. JOHNSON, formerly test pilot, Douglas Aircraft Co., Santa Monica, is now with United Air Lines at Cheyenne, Wyo.

HARVIE H. STRAWN, service manager, International Harvester Co., has been transferred from Long Island City, N. Y., to Boston.

C. E BATSTONE, formerly local manager for the International Harvester Co. at Worcester, Mass., has been transferred to Boston where he is doing special sales work on heavy-duty trucks. Mr. Batstone is a past Chairman of the SAE New England Section.

BERNARD C. WHITE, who was draftsman with General Motors Truck & Coach, Pontiac, Mich., is now with the United States War Department, Air Corps, Materiel Division, Design Unit, Dayton.

GEORGE B. GASTON, JR., stylist-designer, Stinson Aircraft Division, Aviation Mfg. Corp., has been transferred from Wayne, Mich., to Nashville, Tenn.

JAMES B. MORTIMER, district service manager, General Motors Products of Canada, Ltd., has been transferred from Regina, Saskatchewan, to Edmonton, Alberta.

BEN NEWTON, formerly sales supervisor, Sunland Refining Corp., Fresno, Calif., is president and general manager of California Farmers Cooperative, of the same city.

Two SAE Student Branch members in the Class of '40 at M.I.T. have reported that they had jobs lined up prior to graduation last month. **RICHARD H. WHEELER, JR.,** entered the production department of the Walworth Co., and **JAMES E. THOMAS-STAHLE,** has joined the mechanical engineering department of Glenn L. Martin Co. **NICHOLAS N. ERSHOV, WILLIAM Z. HWA,** and **WENSLEY BARKER, JR.,** plan to do graduate work.

ROBERT C. McGUIRE is project engineer with American Airlines, Inc., at New York Municipal Airport, North Beach. He previously was engineer with the Republic Aviation Corp., Farmingdale, Long Island.

JAMES C. WINSLOW has joined the engineering staff of Northrop Aircraft, Inc., Hawthorne, Calif. Previously he was engineer with the Douglas Aircraft Co., El Segundo, Calif.

BARTON G. NORDLING, formerly a member of the SAE Student Branch at Oregon State College, has joined the Willamette Hyster Co., Portland, Ore., as machine shop material man.

Obituaries

Harry E. Figgie

Harry E. Figgie, vice president and director of the Standard Steel Spring Co., died suddenly June 13, at White Sulphur Springs, W. Va., while attending the 35th Anniversary Meeting of the Society. He was 53 years old and had been a member of the SAE since 1913.

In 1909 Mr. Figgie received his Bachelor of Science degree in civil engineering at the Case School of Applied Science. Soon afterward he joined the Carey Construction Co., advancing to engineer and superintendent. Entering the sales engineering department of the Perfection Spring Co. in 1911, his outstanding work won him the position of sales manager. In 1922 he went to the Standard Steel Spring Co. in a similar capacity with that organization until his death. Mr. Figgie was made vice president of the latter company in 1929.

William R. Mitchell

William R. Mitchell, executive vice president, National Acme Co., Cleveland, died at his home in Cleveland Heights on May 8, after a long illness. He was 62 years old.

Mr. Mitchell, who started with the company as a buyer in 1898, was in terms of service its oldest employee. He was made superintendent of the products division in 1912, supervising plans and construction of the company's Coit Road plant. The following year he became an Associate Member of the Society. He later was advanced by his company to general superintendent and, during the 20's, was for three years manager of the Detroit sales division. Mr. Mitchell returned to Cleveland as vice president and, in 1933, was made executive vice president.

He was active in community affairs and was a member of the Cleveland Chamber of Commerce.

Morgan J. Hammers

Morgan J. Hammers, president of Electrol, Inc., New York, and a member of the Society of Automotive Engineers since 1917, died in Chicago, April 28. He was 65 years old.

Mr. Hammers was secretary-treasurer of the General Engineering Co., Detroit, and had specialized in steam and gas motors and automobile axles, when he joined the SAE. Soon afterward he left the automotive industry to become one of the pioneers in the domestic oil-burner business. In 1921 he organized the American NoKol Co., which manufactured the first fully automatic home oil burner. In 1928 his company merged with Petroleum Heat & Power Co., and Mr. Hammers was named first vice-president and general manager.

In 1934 and 1935 Mr. Hammers served as chairman of the NRA Code Authority of the Oil Burner Industry and president of the American Oil Burner Association. He was elected president and general manager of the Electrol Co. in 1935.

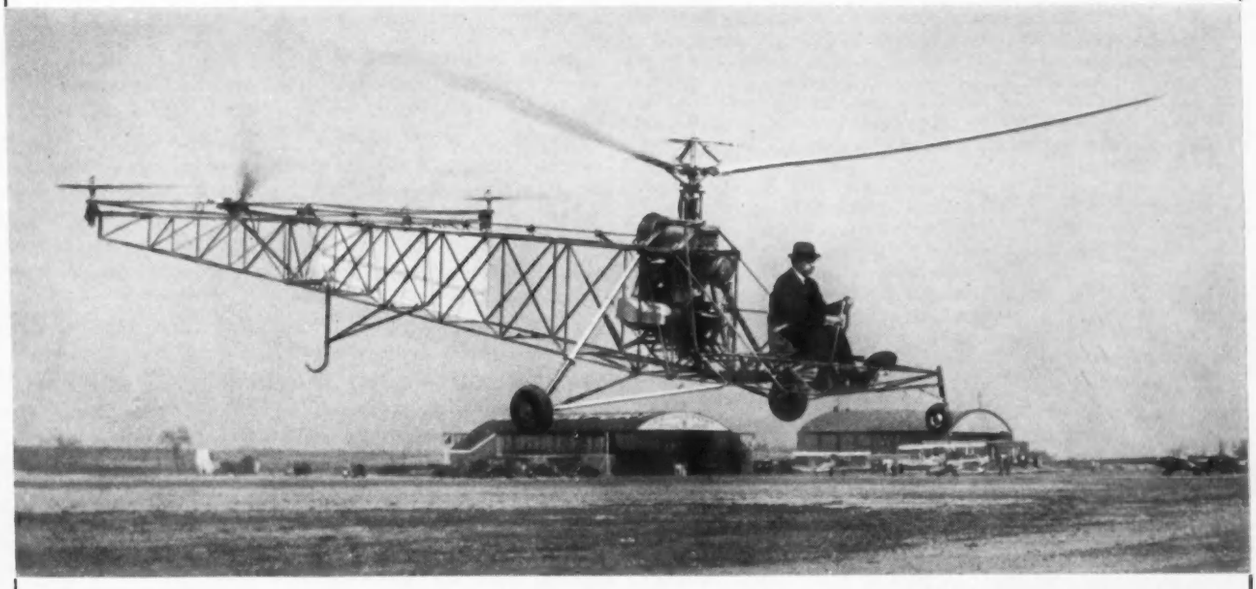
Edward P. Hammond, Sr.

Edward P. Hammond, Sr., president of the Gemmer Mfg. Co., recently died in Detroit at the age of 55 years. He had been ill for several months.

Immediately after leaving college he joined the Gemmer organization, and in 1912 became its president. He was connected with the Federal Motor Truck Co. in 1910 and in 1912 served as its treasurer. He served as a director of many Detroit concerns, including the Michigan Fire & Marine Insurance Co. and the Peninsular State Bank.

When the Gemmer Mfg. Co. became an affiliate member of the Society in 1917, Mr. Hammond was named its representative, and he continued in that capacity until his death.

Sikorsky Demonstrates Experimental Helicopter



IGOR I. SIKORSKY at the controls of the Vought-Sikorsky VS-300 Helicopter, on its successful flight demonstrations at Stratford, Conn., May 20. Piloted by Mr. Sikorsky, the helicopter rose vertically approximately 30 ft, hovered motionless over one spot, and then flew about 200 ft across the field before descending vertically to the ground. Several shorter flights were also made.

Mr. Sikorsky, who is engineering manager of Vought-Sikorsky Aircraft, stressed the fact that the helicopter is still in an experimental stage, but that the flights had clearly demonstrated that the problems which have balked helicopter designers for years had been successfully solved.

Using data already obtained from the experimental model, he said, it would be readily possible to produce a two-seater helicopter powered with a 200 hp motor. Such a craft, he continued, would be able to take off and land in small spaces; would be able to travel forward at any speed between zero and slightly more than 100 mph, which would be its normal cruising speed; would be able to move sideways or backwards at speeds up to 25 mph; would have a ceiling of more than 12,000 ft; and would have an initial rate of climb in excess of 1000 fpm.

Two earlier helicopters were built by Mr. Sikorsky in Russia some thirty years ago, but this was the first to fly successfully.

35th Anniversary Summer Meeting

(*Continued from page 28*)

zero power at certain altitudes, Mr. Taylor wondered why, when these two methods of supercharging were combined, a definite power value was obtained at the same altitude. In other words, he asked, doesn't zero plus zero equal zero? In reply Mr. Pierce explained that the zero power values were obtained by formula, and that he does not believe that this actually would be the case.

Reporting experience with the method on large compressors, F. B. Doyle, Ingersoll-Rand Co., asked whether anyone had tried using a power wheel at the inlet of the impeller to control the inlet temperature. Replying in the negative, Mr. Pierce brought out that the method of control used depends upon the efficiency, adding that they are obtaining a 72% temperature coefficient.

Pointing out that axial-flow compressors have a temperature coefficient of from 84 to 86%, one discusser asked whether this type had been considered. He was answered by Mr. DuBois who explained that the excessive length of axial-flow compressors had placed them out of the picture for use in supercharging aircraft engines.

The Problem of Valve-Head and Valve-Stem Deposits – **A. T. COLWELL, Thompson Products, Inc.**

DEPOSITS on valve stems today are causing about 50% of the valve trouble in the automotive field, and slightly more than 50% in the aircraft field, Mr. Colwell revealed. He added, however, that aircraft valve trouble is proportionately far less than valve trouble in the automotive field. He contended that, although much work has been done on varnish and lacquer deposits, most of it has applied to pistons and rings, with valves receiving only passing interest.

The real cause of the deposit built-up, he reasoned, is apparently traceable to fuel and oil since the deposits occur heavily in diesel motors, particularly when low-grade fuel is used, and because engines operating on butane are reported to be practically free from such deposits. Furthermore, he continued, the diversity of opinion expressed in a survey made to collect data for his paper, and of steps taken to improve this build-up condition, indicate again that motors have individual characteristics and that no standard procedure works for all cases.

Mr. Colwell divided valve deposits into six classifications: those on the valve head; the hard, flint-like deposit from operation; varnish on the stem; deposits under the head and on the stem at the valve-head end of the guide formed by shuttle driving; deposits on intake valves; and deposits on valve seats.

The fact that any oil will oxidize or decompose at some temperature found along the valve stem makes a complete solution of the build-up problem most difficult, Mr. Colwell pointed out. It has been definitely proved, he continued, that oils with good oxidation resistance at high temperatures cause the least trouble. The design problem, therefore, he concluded, is to attempt to get a valve-stem temperature at the top of the guide which will not cause oil decomposition; or to meter the oil so that the deposit formed is not thick enough to cause trouble between overhauls; or to remove the deposit in some way as it is formed.

Comparing automotive and aircraft remedies, he brought out that the automotive status is more confusing because operating conditions vary far more. He then presented and discussed a number of aircraft remedies and 12 automotive remedies for preventing valve deposits.

DISCUSSION

The difference of opinion as to the causes of valve deposits brought out in Mr. Colwell's paper received further emphasis in discussion.

That decomposition of the lubricating oil is the major cause of valve deposits in aircraft engines was the contention of G. L. Neely, Standard Oil Co. of Calif., who read from prepared discussion. This decomposed oil, he explained, forms a binder which holds the deposits together. This decomposition and subsequent deposit formation, he claimed, can be avoided by the use of special aircraft lubricants to which has been added a compound to give detergency. He described a laboratory machine that rates the valve-sticking tendencies of lubricating oils in which an electric horn sounds whenever a valve is stuck open. Presenting test data obtained from this apparatus that showed the superiority of the compounded aircraft lubricants over commercial Pennsylvania oils with respect to deposit formation, he announced that these laboratory results correlate well with flight tests.

A. Ludlow Clayden, Sun Oil Co., contributed arguments to show that the fuel "has a great deal to do" with valve deposits. Since deposits are worse with low manifold heat when much of the fuel is unvaporized, he reasoned, the fewer the liquid droplets in the mixture, the less likely is the formation of valve deposits. The fact that no deposits are obtained when butane and propane are used as fuel, confirms this statement, he added. The difference between "easy" and "hard" operation, he pointed out, is simply the difference in combustion of the fuel. The use of lighter lubricating oils in automotive equipment also affects the problem, Mr. Clayden brought out, explaining that, as the distillates become lighter and lighter, the greater is the tendency to form valve deposits.

Photographs describing graphically the action of exhaust gas on the valve and valve guide were displayed by Carlton Kemper, National Advisory Committee for Aeronautics, in presenting the prepared discussion of W. K. Ritter of the same organization.

Explaining that the exhaust-gas flow is rendered visible by kerosene vapor in one photograph and by aluminum dust in another, he showed that the gas impinges violently on the end of the valve guide, and that any residue particles of incomplete combustion of fuel or oil carried in the exhaust gas might thus by mechanical action of their own kinetic energy be driven into the guide clearance space.

Arrangement of the valve installation so that the supersonic velocity gases of the free exhaust period do not follow the valve contour too closely and cannot impinge directly on the end of the valve guide, appears desirable, he concluded.

A. L. Beall, Wright Aeronautical Corp., reminded that the problem of deposits on the valves of aircraft engines is not new. He suggested three remedies: (1) to keep the valve-stem temperature so low that deposits cannot form; (2) some form of dry valve lubrication; or (3) to produce oils that will not form binders for deposits. The last, he believes, is the most practicable solution. The type of deposit that is hazardous and more serious than that causing bell-mouthing of the guide, he contended, is the deposit that forms on the upper end near the tip of the valve. This deposit can appear so clear and uniform, he said, that inspectors have believed that valves coated with it were clean.

The C.U.E. Cooperative Universal Engine Design for Aviation Engine Single-Cylinder Research – **A. W. POPE, JR., Waukesha Motor Co.**

THE fact that 12 C.U.E. engines have been built and 10 more are under construction demonstrates the effectiveness of the cooperative method in stimulating and executing research, Mr. Pope, declared concluding his report of the development and design of this engine.

He recalled that some years ago the SAE Ignition Research Committee expressed its need for a standardized single-cylinder engine

which would "take actual full-scale aviation engine cylinders into the laboratory under accurately controlled operating conditions for aviation spark-plug research." Such an engine, he continued, was built by his company and displayed at the SAE Semi-Annual Meeting in 1937. Although this engine did meet the needs of the spark-plug manufacturers, he said, it did not fill the needs of the petroleum industry, which was interested primarily in lubricating oil and fuel tests.

A volunteer group, organized at the 1937 SAE Semi-Annual Meeting, first listed the features which such a design must include and then a small design subcommittee was formed to study and coordinate the requirements, he reported. Counting the original spark-plug test engine, he revealed that five complete designs were made before a combination was developed which appeared to meet all requirements in a satisfactory manner. He added that three months of intensive work were required.

The single-cylinder crankcase design was laid out to provide for the Wright Cyclone air-cooled cylinder, 6⅛ x 6⅞ in. bore and stroke, the largest in general use at the time, he explained. With the Wright Cyclone cylinder installed, he specified that the weight is 4900 lb.

A detailed description of the C.U.E. design and construction comprised the major part of Mr. Pope's presentation, covering such features as: the balancing system; main roller bearings; smooth-walled crank chamber; lubrication; crankcase construction; temperature control; crankcase seal; accessory drives; crankshaft; connecting rod; speed; spark indicator; flywheel; reverse rotation; dynamometer coupling; and fuel injection system.

Comparison of C.U.E. Engine Installations – A. L. BEALL and M. H. Young, Wright Aeronautical Corp. (Presented by Mr. Beall)

"NO two of the Cooperative Universal Engines as now set up are likely to provide comparative data, and none seems to be sufficiently closely related to multicylinder engine practice to insure comparability of results with the large engine," the authors concluded from a study of the data made available in their paper. The data were compiled, they explained, to compare existing installations of the Cooperative Universal Engine with particular reference to their probable use for the joint testing of aircraft-engine lubricating oils. They reported that the data were volunteered from the laboratories of the Shell Oil Co., Sinclair Refining Co., Socony-Vacuum Oil Co., Standard Oil Development Co., Tidewater Associated Oil Co., and Wright Aeronautical Corp.

The C.U.E. engine, they explained, consists of a crankcase unit including shaft and accessory drives manufactured by the Waukesha Motor Co., upon which is mounted a connecting rod, piston, and air-cooled cylinder of an aircraft engine.

After discussing the divergence in installation details and accessories among the installations, bringing out items of special ingenuity or usefulness, the authors emphasized that some compromises are needed from each laboratory to make the units similar. Further compromise in installation detail or practice also is indicated to insure comparability with the multicylinder engine, they added, noting that the data needed to make the compromises are available.

The primary object – to substitute the single-cylinder engine for a multicylinder engine test as a measure of the quality of an aircraft-engine lubricating oil – has sufficient merit, the authors concluded, and, if fulfilled successfully, it will result in such economy as to warrant substantial effort in its completion.

DISCUSSION

Representatives of laboratories using the C.U.E. engine and cooperating in its development expressed their enthusiastic agreement with Messrs. Pope, Beall, and Young as to the value of the cooperative achievement in discussion following presentation of the two papers. While many pointed out special reasons for differences in installation details and accessories, all conceded that compromises must be made to give more comparable data and closer correlation with multicylinder operation.

Explaining why the C.U.E. engine set-up used in his laboratory differs from others, Dr. A. G. Cattaneo, Shell Development Co., reported that a magnetic-type dynamometer and an 85-hp Ford engine were selected to measure the power and start the C.U.E. engine, instead of an electric dynamometer that also can run as a motor for starting, because of economy and simplicity. "All in all," he said, "we thus saved both on the initial investment and the electrical installation, the latter requirement being reduced from about 50 kw to 5 kw." Some of the differences between the installations, he continued, are doubtlessly due to differences in the purposes for which the C.U.E. engine is used. "For example," he specified, "our unit is used for fuel testing, and we have made our lubricating oil system as reliable and automatic as possible without regard for similarity with full-scale practice except, of course, as far as the cooling of the piston is concerned, which affects fuel rating."

W. M. Holaday, Socony-Vacuum Oil Co., explained that the C.U.E. engine was made heavy to eliminate fear of injury during its operation.

In addition to comparing oils and endurance testing, the C.U.E. single-cylinder engine offers a bigger chance for improvement, pointed out F. C. Mock, Bendix Products Division, Bendix Aviation Corp. – it encourages the laboratory man to strike out boldly and try to do things that he otherwise would not attempt.

A. E. Miller, Sinclair Refining Co., elaborated on the use of the C.U.E. engine for improving aircraft-engine lubricants. The cheapest and most satisfactory way of improving them, he said, is by running the oils in the C.U.E. engine. In running comparative tests on lubricating oils, he emphasized the importance of keeping all parts and conditions exactly the same. Even slight differences in parts, he brought out, may make more difference in the test results than will the difference in oils.

DIESEL-ENGINE SESSIONS

Chairmen

W. G. Ainsley **C. G. A. Rosen**

Ideas thrown out as bait drew an avalanche of pertinent discussion at the two Diesel Engine Sessions. These centered on definitions and indices for comparing results of diesel performance tests made in different laboratories and the load-carrying capacity phenomena of bearing surfaces. Comments on wear-resistant coatings were closely tied in with discussion of the latter topic. Interest likewise was intense in an analysis of new applications of aluminum in high-speed diesel engines and a progress report of the CFR full-scale engine tests.

SAE Golf Champion

John Oswald, Oldsmobile's chief body engineer. His total for 36 holes was 150. Runner-up to Mr. Oswald was C. W. McKinley, of AC Spark Plug

Full Scale Engine CFR Progress Report **– C. G. A. ROSEN, Caterpillar Tractor Co.**

THE CFR Full-Scale Engine Test Committee is working, first, to clarify the issue of automotive diesel fuel specifications, and secondly, to determine those properties of analyses which influence engine operation and engine deposits, Mr. Rosen explained in the introduction of his report. Primary membership on the committee is made up of engine men representing the four primary types of automotive diesel engines, namely: direct-injection or open-chamber; swirl-chamber; energy-cell; and pre-combustion chamber. Likewise represented are the petroleum industry, colleges and government agencies participating in the tests, petroleum men, to obtain and offer for sale the four selected reference fuels; and an instrumentation and procedure group set up to find ways and means of standardizing procedure and instrumentation.

Work is progressing, he reported, on the influence of cetane, volatility, viscosity, and gravity of diesel fuels as they affect cold starting, smoothness, low-temperature starting, smoke, power output, fuel consumption, smell, and engine deposits. Four reference fuels have been established and are being used in these studies.

To date, Mr. Rosen revealed, reports have been received on engine testing conducted in nine different laboratories. In evaluating these data as submitted, he stated, in informal remarks following his paper, that these preliminary results indicated that, when low-temperature combustion-chamber envelopes are approached, high cetane helps idling, light-load, and starting characteristics; smoke is the most pertinent characteristic influenced by volatility, decreasing as the volatility increases; high volatility plus high cetane eliminates stink; and low gravity fuels give best horsepower output at lowest fuel consumption.

Among observations on tests conducted by individual laboratories, using different types of engines, were the reports that high-cetane fuel gave the most hours before ring sticking; that lowest engine deposits came from the fuel which has combined good cetane rating and high volatility; and that the rate of pressure rise correlates with the cetane number.

DISCUSSION

That there are other factors which influence engine deposits besides the cetane number of the fuel, was reported by L. E. Hebl, Shell Oil Co., Inc., whose company is participating in the study. Listing the test fuels according to deposits measured in the combustion chamber, he stated that fuel with the highest cetane number gave the least deposits, and that the fuel with the highest volatility gave slightly more. Considerably more deposits resulted from use of the fuel with the lowest cetane number, and the worst offender was the fuel with the lowest volatility.

Tests reveal, discussion brought out, that the lubricating oil as well as the fuel, influence engine deposits, and that deposits are greater with straight mineral oil than with certain compounded oils.

Commenting on the program of the committee, A. J. Blackwood, Standard Oil Development Co., who heads the instrumentation section, said that the performance characteristics of the fuel with the highest cetane number (56.1) are best, and that the committee may find it necessary to test additional fuels having higher cetane numbers. Concerning the influence of lubricating oils on engine deposits, he predicted that the committee would standardize on a lubricant to use in the tests.

The smoke indicator developed at Pennsylvania State College was described by Prof. Paul H. Schweitzer, of the College, who also explained the misfire method of measuring the cetane number of a fuel. Slides were used by Prof. Schweitzer in presenting his discussion.

An Analysis of the Charging Process in the Two-Stroke Engine **– C. F. TAYLOR, Massachusetts Institute of Technology.**

WARNING that scientific analysis of the two-stroke internal-combustion engine has been neglected for the development of the four-stroke operation, Prof. Taylor emphasized the need for specific definitions and indices whereby the performance of two-stroke engines tested in different laboratories and by different personnel can easily be compared.

In the case of the charging process, the author stated that it is important to know: how much fresh charge is available in the cylinder for combustion; how much charge is delivered through the inlet ports; what charging pressure is required, and how much work is expended in charging.

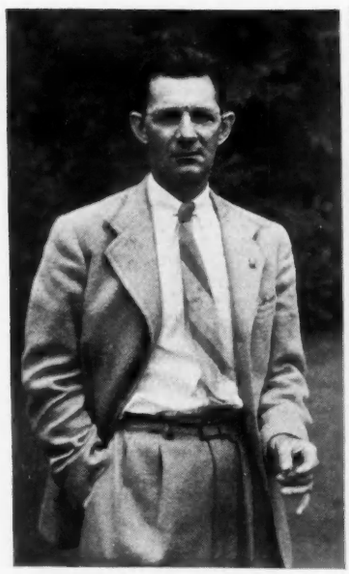
To stimulate discussion on the subject, Prof. Taylor offered several indices applicable for evaluating the scavenging process in all types of two-stroke engines. Further he compared the scavenging performance of actual engines with hypothetical scavenging processes and gave reasons for the differences. A feature of his paper was the explanation of a new method for measuring scavenging efficiency developed at M.I.T., and the results obtained.

The ideal charging process, toward which engineers are working, according to Prof. Taylor, would consist of "the admission of the fresh charge (which may be air or a mixture of fuel and air) through the inlet ports in such a way that it displaces the residual gases from the previous stroke without mixing or exchanging heat with them, or with the engine parts."

DISCUSSION

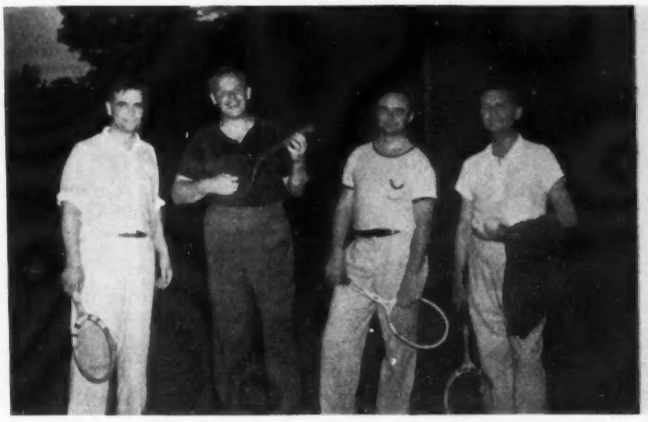
Prof. Taylor's expressed belief that his definitions would evoke discussion proved to be well founded. There was no challenge to his contention that a need exists for definitions and indices whereby the performance of two-stroke diesel engines tested in different laboratories can be compared, but exceptions were taken to some of the definitions and indices which he suggested. These came in written discussions prepared by W. K. Ritter (presented by Carlton Kemper), National Advisory Committee for Aeronautics; by Prof. P. H. Schweitzer; and by Prof. L. C. Lichty, Yale University (read by Prof. C. W. Phelps, Purdue University).

Commenting on the discussions, Prof. Taylor declared that nothing can be accomplished in general discussion – and that such definitions can best be developed in a committee made up of men who are working on the problems which they affect. He argued that the definitions proposed by the others are just as subject to argument as his own, in that they also are based upon assumptions. The whole matter, he continued, is a question of assumptions and not absolute considerations – unless we define the assumptions beforehand.



Frederick W. Mesinger was chairman of the Men's Golf Committee

Mrs. J. R. Frantz won the ladies' golf championship



P. B. Taylor, Furber Marshall, C. Fayette Taylor and Graham Edgar

F. C. Horner and P. F. Mallon

Remarks of men gathered in groups after the close of the session indicated that there is just as much need for basic definitions in the 4-cycle field as in the 2-cycle field.

New Applications of Aluminum in High-Speed Diesel Engines **– FRANK JARDINE, Aluminum Co. of America.**

THE increasing demand for lighter diesel engines by the U. S. Navy and by long-distance truckers is spotlighting aluminum as essential for major diesel-engine castings, Mr. Jardine stated. In practically every division of transportation, he continued, the lightweight power unit is becoming more important, and some of the new highway laws make the use of weight-saving aluminum a necessity.

The author theoretically dismantled a conventional light-weight, high-output diesel built by the National Supply Co. Unit by unit he showed how aluminum has been substituted for iron and steel, and gave specific reasons for each substitution. Parts thus covered were: crankcase and cylinder block, cylinder sleeves, pistons, bearings, cylinder heads, valve seats, camshaft gears, flywheel housing, and gear cover. This particular engine, Mr. Jardine pointed out, weighed approximately 7.8 lb per hp, and the aluminum units were substituted with practically no change in design or manufacturing practice.

"The cost of an aluminum-and-steel engine over the cost of the iron-and-steel engine," Mr. Jardine said, "will depend on the design, quantity, and size; but the average aluminum-and-steel engine should cost approximately 25¢ to 40¢ more per lb of weight saved as compared to the heavy engine." In the west, he reported, freight-line operators feel that a pound of weight saved is worth a dollar a year when the unit operates 100,000 miles during that period.

DISCUSSION

Economics have more bearing on the use of aluminum than on its engineering problems, declared F. G. Shoemaker, Detroit Diesel Engine Division, General Motors Corp. Aluminum is handicapped more by its cost than anything else – and until cheaper aluminum is available, its use will be limited, except where weight is of tremendous importance, he believes. Aluminum pays dividends in motorcoach operations, but would not be worth the additional cost in passenger cars "whose main function seems to be to fill parking lots."

That the use of aluminum in diesel engines has not passed the experimental stage, was the opinion advanced by H. L. Knudsen, Cummins Engine Co. His company, he said, has built and is building experimental diesel engines making considerable use of aluminum. Slight changes in the cylinder block and cylinder head, he believes, will make such engines practical. There is no doubt, he added, that the decrease in weight will mean a saving for truckers.

In answer to a question by Arthur W. Pope, Jr., Waukesha Motor Co., Mr. Jardine explained that the placing of gatings for stressed parts is determined by an X-ray analysis. Parts may have to be studied by X-ray and the gatings changed several times, he said, but the result will be a good sound casting.

Responding to a question as to the importance of the contact between iron sleeves and the aluminum block, the author said that there is a tight contact but that it has little influence on the flow of heat through the sleeve.

Mr. Jardine also stated that aluminum bearings work well with a hard shaft and are working out well experimentally on trucks. Rolls-Royce, he stated, is using them.

Wear Resistant Coatings **– J. E. JACKSON, Caterpillar Tractor Co.**

"THE problem of scratching or scuffing of diesel engine cylinder liners during the run-in of the engine may be largely eliminated through a caustic-sulfur treatment for the honed liners before assembly," Mr. Jackson contended.

Illustrating the nature of this coating before and after run-in by photomicrographs flashed on the screen, he continued:

"Through the various properties of the caustic-sulfur treatment, the run-in is given ample opportunity to produce the most favorable wear-resistant coating which the liner material is capable of forming . . . the coating will experience wear, but at a very low rate. As a small amount of surface is worn away, a new layer of the wear-resisting coating will be formed in the next reciprocations of the piston." Slides also were shown to illustrate the honed and run-in surfaces of the untreated liner and the surface of the liner "as scratched."

Newly assembled diesel engines require a run-in before being placed in service, he explained, to give them a final inspection and to bring about a "mating" of all bearings. The difficulty of lubricating the smooth honed liner bore during the period of structural change makes "scratching" or "scuffing" imminent during run-in, he pointed out.

Mr. Jackson emphasized that the surface treatment is no cure-all and that its use does not permit less rigid specifications of lubricating oil and liner materials.

Load Carrying Capacity Phenomena of Bearing Surfaces **– MACY O. TEETOR, Perfect Circle Co.**

AFTER stating that load-carrying capacity of a bearing surface is affected by surface finish, coefficient of friction, speed, thermal conductivity, lubrication, material, and so on, Mr. Teetor emphasized its dependence on surface temperature, pointing out that this temperature is affected by all factors. Surface temperature, he explained, is the temperature of the surface material, microscopic in depth and expanse. High surface temperature, he said, is the cause of surface failure, and bearing surfaces fail because the areas in contact reach the melting point of the material.

Another factor stressed by Mr. Teetor is surface finish. It affects

the load-carrying capacity, he explained, because it determines the actual area and distribution of that area in contact. He believes it reasonable that a bearing surface carrying a given load satisfactorily is dotted with high-pressure areas, microscopic in size and depth, that melt and cool almost instantaneously. The gradual oxidation that takes place, he reasoned, could be the process of normal wear. It is only when the high-temperature areas get too large and deep to cool instantaneously, he pointed out, that failure occurs. Because of their ability to cool, he continued, rough surfaces have greater load-carrying capacity than smooth surfaces. Load-carrying capacity decreases as the contacting area increases and can be increased by dividing the bearing surface into smaller areas, he said. The capacity of such an interrupted surface can be increased further, he added, by filling the grooves or cavities separating the small bearing areas with a suitable material.

DISCUSSION

At Chairman Rosen's suggestion discussion of Messrs. Jackson's and Teetor's papers was held after the reading of both.

Discussing Mr. Jackson's paper, A. L. Beall, Wright Aeronautical Corp., pointed out that in the break-in of an engine it is desired to remove a minute amount of material from the ring surface and burnish the cylinder bore as rapidly as possible to reduce blowby to a minimum. For this purpose, he said, it would seem that a schedule which reaches a substantial increase of load in the first hour would be more effective than the long idle time suggested by the author. It is possible, he remarked, that 20% or even 50% load could be achieved in the first hour with a better break-in and without scuffing. Experience with several types of surface coatings, he added, indicates that, while they may be helpful in preventing scuffing, they do require an excessive time for run-in.

Another discussion, which augmented Mr. Jackson's paper, was presented by G. L. Neely, Standard Oil Co. of Calif. The most significant portion of the paper, he said, dealt with the deleterious effect of cold working and deformation of liner surfaces in the final machining and honing operations, which often cause the grains of cast iron to become loosened or distorted without being removed from the surface. "Our experience," he continued, "shows that this is the major cause of scuffing during break-in and that the Surfide treatment either removes these particles or renders them incapable of causing scuffing."

Further, he said, "this treatment removes free ferrite and certain other undesirable constituents in the metal surface, but it does not attack the graphite particles. It is evident, therefore, that the graphite is exposed by the treatment and the beneficial effects of this material are immediately available. In addition, the treated surface is coated with a sulfide film which prevents welding and promotes spreading of the oil film. The surface pits produced by the action of the chemicals serve as reservoirs for the oil."

That scuffing can be done cold as well as hot, was pointed out in discussion of Mr. Teetor's paper, by A. F. Underwood, General Motors Research Laboratories, who declared that it is mainly due to molecular attraction. The surfaces must be absolutely clean for cold scuffing, a condition not encountered in automobiles where the surfaces are "contaminated" with oil and oxides, he stated.

Early belief, Mr. Underwood stated, was that bearings "burned out." We have since learned, he said, that fatigue comes first, causing heat to accelerate and the bearings to break down. The same is true in scoring, he added.

In a paper at the recent M.I.T. Conference on Friction, Mr. Underwood stated, it was shown that the anti-score quality of metal is based upon the place of the element in the periodic table. Aluminum, magnesium, copper, and zinc, are unsatisfactory, while tin, lead, and cadmium, further down on the table, are satisfactory. This, he said, leads to the conclusion that antimony and bismuth, despite their hardness, should have good anti-score quality.

He thoroughly agreed with Mr. Teetor that smooth surfaces do not wear as well as rough – but, he said, this is because they are not so contaminated with oil and oxides. He argued that perhaps the extended life of the deep grooved piston rings shown by Mr. Teetor was because they were more conformable to the cylinder-wall surface and therefore had greater surface area.

Mr. Beall commented that some of the phenomena presented by Mr. Teetor confirm some of his experiences, particularly with piston rings. "It has been noticed," he said, "that where the burnished area begins near the edge of the ring, the damage to the surface does not appear to become severe before the edge of the ring is reached. If the burnished area begins near the center of the ring face and has an appreciable distance to travel before reaching the ring edge, scuffing will be severe. Again, in my experience," Mr. Beall continued, "it is always desirable to sacrifice the area of a bearing surface in order to improve the introduction and flow of lubricating oil through the bearing. Contrary to theory, the area of a bearing may be reduced and higher unit pressures sustained after lubrication and cooling are improved." The result reported by Mr. Teetor, he said, indicates that we know too little about boundary lubrication and the extent to which we have boundary lubrication between the friction surfaces. It is quite possible, he added,

Photographic Contest

Dr. H. C. Dickinson at left, and Tore Franzen at right, were two of the 25 active participants in the SAE Journal Photographic Contest which was held during the Grand Ball on Wednesday evening, and in the center is a part of the crowd just before the contest started

that no great sacrifice in wear will result from increase in unit pressure brought about by improved lubrication. In concluding, Mr. Beall stated that in his experience, oxides interposed between surfaces in chafing contact have been effective. Their use as proposed by Mr. Teetor is new, he added.

Roughing alone, said Mr. Neely in discussing Mr. Teetor's paper, can do a large percentage of good in reducing wear, but only a percentage. The lubricant also is an important factor.

Dr. Ulric B. Bray, consulting petroleum technologist, seconded this contention. He also voiced his agreement with Mr. Teetor's contentions. With the narrow rings favored by Mr. Teetor, he said, the surface of the piston ring reaches the melting temperature, whereas the surface of the cylinder wall does not. Thus the piston ring wears and saves the surface of the cylinder wall. If both surfaces reached the melting temperature, he added, a weld would take place. The part of the lubricant, Dr. Bray continued, is to keep the temperature down.

Questioned about the effect of boundary lubrication on the load-carrying ability of the bearing surfaces, by Dr. Alfred G. Cattaneo, Shell Development Co., Mr. Teetor stated that he did not know the answer in that his tests were run dry. Replying to another discusser, Mr. Teetor said that he did not have much data on the rate of wear because the tests were run up to the time that wear started.

TRUCK, BUS & RAIL CAR and TRANSPORTATION & MAINTENANCE SESSIONS

Chairmen

B. Frank Jones — **G. W. Laurie**

H. O. Mathews

That the truck industry has no smug feeling of having reached its goal for engine design, that the operators are taking an important part in spurring them on, and that the petroleum industry will cooperate in every way possible to design better fuels and lubricants for better engines, was emphatically stressed by speakers and discussers participating in the joint Transportation & Maintenance and Truck, Bus & Railcar Session on Monday morning. The next day operators got together for an old-fashioned round-table discussion of topics voted most important by fleet men in answering a questionnaire listing some 150 problems encountered.

Increased Power per Unit Gross Weight **– AUSTIN M. WOLF, Automotive Consultant.**

FULL cognizance of the fact that the power-weight ratio of a vehicle is the fundamental factor which no trick or gadget can possibly circumvent, was brought about by the formulation of the SAE Truck Ability Rating, Mr. Wolf stated. A better power-weight ratio can be accomplished, he explained, by three expedients, singly or collectively, these being: increasing the power of the engine; conserving the power developed; and reducing the weight of any of the components making up the gross vehicle weight.

The author continued with an analysis of past and present practices covering the ratio of chassis weight to gross vehicle weight for 1935 and 1940; also horsepower to gross vehicle weight for 1931, 1935, and 1940. Some typical truck models were scrutinized for specification and design trends over the past ten years or more, emphasizing the horsepower and torque per pound chassis weight, as well as the gross vehicle weight per pound-foot engine torque.

In pointing out hopeful solutions and goals for future development, Mr. Wolf stressed that, "it is vitally important to incorporate into the design and construction of the vehicles, those measures which will insure long life and continued output comparable with the original, without forcing remedial measures in the field of operation."

DISCUSSION

While a few of Mr. Wolf's premises were attacked and some discussers took issue with certain points brought out by the author, his conclusions drew no fire when Co-chairman Jones asked for comment.

It was Merrill C. Horine, Mack Mfg. Corp., who drew attention that in the parallels which Mr. Wolf presented between the power and rate proportions of similar models in 1931, 1935, and 1940, these comparisons are between published ratings. "Even accepting the ratings of horsepower, of torque, and of chassis weight," he said, "those of gross vehicle weight, as everyone connected with the industry must know, are neither comparable one with another at any given time nor with those of the same model in different years."

"There are limits," Mr. Horine declared in commenting on Mr. Wolf's suggestions on raising specific output. He pointed to the more costly parts, increased weight, and complicated maintenance that are brought about by increased bmep and higher speeds. The problem of increased performance will be solved, he declared, "by a little rise in bmep, a little increase in rpm, and a little larger bore." More and more people, he added, are discovering that for a given gross weight and maximum speed, a larger engine is often more economical in use of fuel and oil. "I feel that we will have to reconcile ourselves to bigger holes in our cylinder blocks."

Considerable discussion centered around Mr. Wolf's statement: "On the tachometer there should be a red spot to indicate the speed at which crankshaft torsional vibration occurs, with instruction to avoid it. It is an unfortunate condition that when a truck is pulling hard, even on a level, that the vibration damper is stealing power at the front end instead of permitting it to continue back through the clutch." Everett W. Allen, General Motors Truck & Coach, was the first to question this loss of power as being important. Mr. Wolf countered that it was just one of the many small leaks which should be checked to increase efficiency – and the point came to rest with Col. G. A. Green's (General Motors Truck & Coach) observation that manufacturers should not put out engines that have vibration periods bad enough to need red spots on the tachometer to warn the operator that he should pass them by.

Mr. Allen wound up a brief skirmish on overcoming "middle-aged condition" of trucks with the inference that the older models are suffering more from obsolescence than any other malady.

It was the opinion of Fred B. Lautzenhiser, International Harvester Co., that "the optimum in gear reduction, in load-carrying members, frames, tires, and other parts, assumed in Mr. Wolf's discussion, seems to all but spell out the need for fluid couplings or torque converters."

Better Fuels for Better Engines **– W. H. HUBNER, Ethyl Gasoline Corp.**

"IT is not unlikely that, by 1945, gasoline octane values will reach a level of 95 for premium grade and 85 to 90 for regular-grade motor-vehicle fuels," was one of the interesting prophecies made by Mr. Hubner in his talk on oil refiners' problems. Stating his belief that design of future engines will most likely be in the direction of units of smaller sizes, having higher compression ratios, and yielding

higher power output, he foresaw the necessity for fuels having higher antiknock properties.

Mr. Hubner discussed trends in major characteristics of gasoline, covering such subjects as volatility, antiknock quality, sulfur content, gum content, and chemical composition.

Volatility apparently has reached a leveling-off point, he stated, although the tendency has been toward more volatile fuels. That the trend of antiknock value is definitely upward; that sulfur content is becoming less important from the standpoint of corrosion and its reduction is now largely a question of economics of producing high-octane fuels; that low gum content and good storage stability will remain essential attributes of a good gasoline; and that increasing use of cracked and polymerized materials may necessitate closer adherence to gum tolerances and possibly a re-evaluation of present gum-test methods were further views expressed by Mr. Hubner.

Regarding chemical composition, the author stated that catalytic cracking and reforming appear to have heralded a new era in refining methods. The trend is definitely toward the use of catalysts whether in cracking, reforming, polymerization or alkylation operations, Mr. Hubner said. The fuel of the future, he prophesied, may be a blend of catalytically cracked and reformed gasoline and alkylate, with tetraethyl lead and other antiknock compounds added.

DISCUSSION

When Co-chairman Laurie called for discussion, Mr. Wolf was the first to comment on Mr. Hubner's paper. He remarked: "It is fortunate that Mr. Hubner's and my paper came together in the same session in view of many mutual agreements. Both sound the keynote of improved performance; Mr. Hubner's adds the important aspect of economy."

"Impressive," was Mr. Wolf's comment on one of Mr. Hubner's charts showing advantages of a supercharged engine over a large engine of the same capacity for part-load economy. The full advantages of the supercharger are possible, he added, with a variable drive ratio or with a separate source of driving power to cope with different operating conditions. Mr. Allen reported that in his experience the supercharged engine is never quite able to equal the same economy as large engines of equal power. He asked Mr. Hubner if different fuels were used in the two engines shown in the test he charted.

More reference to the supercharged engine was made by Howard A. Flogaus, J. G. Brill Co., who said that he sees the supercharger of help in maintaining peak-of-torque load which will aid in drive-line problems. Torque converters and fluid flywheels also have possibilities in this direction, he said. Mr. Lautzenhiser remarked that Mr. Hubner's paper as well as that by Mr. Wolf "spells out torque converters." Leo Huff, Pure Oil Co., said that the sooner we get torque converters the quicker we accomplish lower cost of operation.

That all is not well with present-day engine design was strongly indicated by Capt. A. O. Axelson, Columbia Engineering Corp., who reminded the group that we are getting less than 25% of the thermal efficiency of gasoline delivered to the driving wheels. Operations of a test fleet of popular passenger cars equipped with throttle stops, subject to excellent maintenance, operated for economy and not speed, he reported, have shown a very steady decline in miles per gallon. Mr. Flogaus reported experiencing increased fuel and oil trouble in recent years.

Dr. Raymond Haskell, The Texas Co., opined that Capt. Axelson in his remarks erred by not considering the number of hours of labor saved and speed resulting from higher octane number fuels. This was borne out by T. L. Preble, Tide Water Associated Oil Co., who read some computations showing that a fleet operating 10,000,000 miles per year would have a saving of $18,600 in drivers' salaries if the average miles per hour of the fleet were increased 5%.

Written discussion by F. C. Burk, Atlantic Refining Co., showed that even if an engine were available that would go 30% further on 100-octane gasoline, at present prices, such gasoline would cost 57% more. From this example, he said, it is not hard to see that there is such a thing as going too far with this combination of high octane gasoline and high compression engines. He also pointed to complexities which would arise if cars were designed for the highest grade fuels available. Owners of the new cars would benefit, he said, but those owning older models would get essentially no better performance from the higher antiknock quality fuel – and refiners would have to supply the old grades of fuel for such equipment. This, he declared, would lead to a multiplicity of grades and away from mass-production methods.

Answering this, Mr. Hubner stated that Mr. Burk was basing his computations on present-day costs. He forecast that high-octane fuels will be produced cheaply – and stated that he thinks of engines and fuels as progressing hand-in-hand.

Most consideration is given to full-throttle operation, Mr. Horine said in entering the discussion. He pointed out that most vehicles operate at part throttle and under part load and that most waste occurs there. He told of an engine in existence that has a varying compression ratio. The compression ratio increases, he said, as the load goes off, thus giving better part-throttle operation.

Ways and means of increasing performance and economy by increasing compression ratios, were discussed by J. O. Eisinger, Standard Oil Co. of Ind., who urged more judicious use of spark advance and cooler cylinder heads, valves, and intake manifolds. He mentioned the possibility of designing for two types of fuels, one for cruising and the other for use under heavy load.

T. C. Smith, American Telephone & Telegraph Co., focused attention on the confusion resulting from the various methods of arriving at octane numbers. Not only are there three or four methods, he said, but the variations are not constant nor do they vary in the same direction. He urged agreement on one method.

The ASTM – (or CFR Motor Method) is the only recognized standard process, Mr. Hubner answered. The 1939 research method has merit, particularly on rating knock characteristics of fuel in passenger cars during acceleration. There is a possibility, he added, that during the forthcoming CFR tests at San Bernardino some one procedure may be arrived at that will eliminate the confusion.

What will be the future of fuel volatility? Will engine roughness be an objection to very high octane fuels? And, what are the fuel limitations of L-head engines? These were questions asked by William V. Hanley, Standard Oil Co. of Calif.

It was brought out that the classes of gasoline are coming closer together in octane number. Dr. A. E. Becker, Standard Oil Development Co., made the point that octane number value increase means more in the higher brackets.

Errol J. Gay, Ethyl Gasoline Corp., summed up the discussion and came to the defense of fuel in the vapor-lock problem. About 80% of the vapor-lock trouble can be cured by servicing the fuel pump, he stated. Car manufacturers, he added could help avoid the trouble by better placing of fuel lines.

Ideas were many and they flew fast when F. K. Glynn, discussion chairman, asked for remarks following each of the four lead-off papers of the round-table forum. In opening the session Chairman Mathews explained that Mr.

Templin was unable to make the trip from Los Angeles and that Dr. Ulric B. Bray, consulting petroleum technologist of that city, would read Mr. Templin's paper.

***Piston Ring and Cylinder Wear*—ELLIS W. TEMPLIN, Department of Water and Power, City of Los Angeles.**

INDICATING that the interest of the fleet operator would be well met by an average fleet mileage of 60,000 before the first piston ring change, Mr. Templin opened the way for stimulating discussion on the subject of piston-ring and cylinder wear. Such mileage, he asserted, would give most fleets an opportunity to run their vehicles until they need a ring change and then trade them in on new vehicles, thereby avoiding the expense of ring changes.

Tests show, the author stated, that specially coated rings are not standing up as well as older types. This might be due, in some respects, to the fact that the rings themselves were not wholly responsible for their own wear, Mr. Templin continued. Rings are usually changed due to cylinder wear, he said, and indicated that corrosion is, in a great many cases, the destructive factor.

To combat corrosion of the cylinder, the author's report of his own tests using "nitrided and otherwise heat-treated cylinder sleeves and chrome-plated cylinders" suggested one type of solution.

Other proposed methods for extending piston-ring and cylinder life include a system of cooling which carries the water-jacket temperature to a consistent figure of 200 F, and a renewable type of crankcase-oil filter, Mr. Templin said.

Directing his talk to vehicle designers, the author urged that effort should be applied toward maintaining crankcase oil and jacket water at suitable levels of temperature to improve ring and cylinder-wall life. Temperature control, Mr. Templin concluded, seems to be the most tangible factor for the designer to consider.

DISCUSSION

"To me," said Dr. Bray, who discussed Mr. Templin's paper after presenting it, "there seem to be two lines of approach to the solution of this problem; namely, to improve the metals, and to improve the lubrication."

Concentrating on the latter method he argued for the incorporation of oiliness agents and corrosion inhibitors in the oil. In passenger-car engines, he reported, cylinder and ring wear are decreased by as much as 50% through the use of properly selected oiliness agents, and the improvement is even more striking in the case of heavily-loaded diesel engines fitted with hardened alloy-steel liners. With corrosion inhibitors, he added, further reductions in wear appear to be obtained, especially if the engine is subject to numerous cold starts. Dr. Bray agreed with Mr. Templin that the use of an efficient oil filter with replacement of the pack as needed, also contributes materially toward increased ring and cylinder life.

Chairman Mathews entered the discussion to agree that oil filters have an important place in truck operation, but that they are used in places where they do not fit – in low-mileage cold-weather operation. This opinion was seconded by George A. Round, Socony-Vacuum Oil Co., Inc., who declared that during winter months the oil does not get hot enough to flow through the filter in stop-and-go operations. Mr. Round also commented that additives will be more generally used and sounded a warning against use of additive-removing filters.

Challenge of Mr. Templin's statement that temperature control seems to be the most tangible factor for the designer to consider in combating piston-ring and cylinder wear, came from J. F. Winchester, Standard Oil Co. of N. J. He feels that manufacturing methods, operating methods, and operating conditions influence wear, and that the author dismissed the effect of fuels and lubricants with too few comments. He commented that the mileages before ring changes, as shown in the paper, seemed very low, but was reminded by the chairman that Mr. Templin was referring mostly to public-utility fleets which have low annual mileage. The chairman also spoke of the extreme variations in climatic temperatures encountered in Southern California operations.

Capt. O. A. Axelson, Columbia Engineering Corp., voiced his opinion that additives sometimes have other effects than those designed for. He was referring to trouble resulting from the indiscriminate mixing of lubricants with different types of additives. Dr. Bray acknowledged that this is one of the greatest problems of refinery research men. They can't keep operators from mixing oils, he said, and suggested that fleet men should play safe by not mixing oils until they have checked with the suppliers to find out if the types being mixed are compatible.

That high oil consumption cannot always be blamed on piston rings was brought out by T. C. Smith, American Telephone & Telegraph Co., who said that it sometimes is caused by intake valve suction, and worn valve stems and guides. He also spoke of a valve-stem ring which has proved successful in reducing high oil consumption.

***Establishing Proper Preventive Maintenance Periods in Fleet Operations*—W. A. TAUSSIG, Burlington Transportation Co.**

INTRODUCING the subject of proper periods for preventive maintenance, Mr. Taussig contended that "at best their establishment must be based largely on 'cut-and-try' methods backed by adequate experience records." He recommended the following sequence for the operator to follow to establish mileages at which certain parts or units should be inspected, adjusted, overhauled, or replaced:

1. Start with the mileages recommended by the vehicle manufacturer.
2. Study road failure reports after operating on these mileages.
3. Determine if certain inexpensive parts have been destroyed by too infrequent replacement of inexpensive parts.
4. If the cost of handling road failures and the estimated cost of service interruptions appear excessive, decrease the mileage interval for servicing the units at fault.
5. If expensive parts are impaired by failure of inexpensive parts, decrease the replacement period for the inexpensive parts.
6. If very few or no failures exist on certain units, lengthen the period on a few vehicles in the fleet and, if this action is successful, change the entire fleet to the extended period.

DISCUSSION

When Capt. Axelson suggested in discussion the advisability of a "break-down" maintenance system instead of preventive maintenance for light vehicles, where inconvenience would probably be the only result, he drew fire from Jean Y. Ray, Virginia Electric & Power Co., and Leo Huff, the Pure Oil Co. It was pointed out that while road failures of these vehicles would not cost as much in "time-out" expense, these lighter vehicles perform valuable service in getting men and equipment to their destination. Mr. Huff added, however, that much depends upon the character of the fleet, and pointed out that different fleet operations cannot be compared, even in the same industry. Nevertheless, he believes, "perpetual" maintenance is essential.

The deacon's one-horse shay should be a criterion of the vehicle manufacturers, was the opinion stated by Merrill C. Horine, Mack Mfg. Corp. In other words, he said, there is need to bring the service life of the various parts more nearly into line so that there would be need for fewer maintenance periods. Also, he added, so that certain parts are not replaced before their time because it happens to be more convenient and more economical to replace them while performing a necessary service operation on another part.

A call for more service information from the vehicle manufacturer came from T. L. Preble, Tide Water Associated Oil Co., who maintained that fleet operators are in

need of more detail on permissible tolerances and replacement periods for various parts. He feels that the manufacturer should bear the burden of adviser.

Improvements Needed in Chassis Lubrication **– JEAN Y. RAY, Virginia Electric and Power Co.**

THE problem of providing proper chassis lubrication rests with the garage and service station rather than with the manufacturer, Mr. Ray stated when introducing the subject of improvements in chassis lubrication. By keeping up to date on lubricants and lubrication, by using modern equipment, and by considering quality as well as price when buying chassis lubricants, the fleet operator may find that the manufacturer "has not done such a bad job after all," he continued.

Recommending modern lubricating equipment for fleet garages, Mr. Ray said that the saving in time, increased efficiency, and cleanliness justifies the cost of replacing old outfits. He advised keeping "shop, equipment, and tools as clean as do the better-class super-service stations operated by our friends in the oil industry." He urged, too, training personnel to apply the proper amount of lubricant to the fitting instead of "squirting grease at it."

Mr. Ray concluded that lubrication is a form of maintenance and, as such, should be tied in with the preventive-maintenance schedule of every progressive fleet-operating establishment.

DISCUSSION

The manufacturer's problem in making grease cups always accessible is often complicated, revealed Herbert Happersberg, Brockway Motor Co., by the location of grease cups on accessories supplied by other manufacturers.

Mr. Happersberg stressed the necessity to have good light for greasing operations, and of washing vehicles before greasing.

Studebaker's C. H. Wondries told the operators that the manufacturers are anxious to give them what they want – but they must ask for it and be willing to pay more in some instances to get it.

Problem of Maintaining Appearance of Motor Vehicles **– LEO HUFF, The Pure Oil Co.**

TOO much time and money are spent painting or repainting motor vehicles, is the opinion of Mr. Huff, who led off discussion on maintaining motor-vehicle appearance. Twenty-five years ago, the author stated, it took three weeks to clean and paint a tank truck and, although modern facilities and quick-drying paints have reduced the process to a five-day operation, the lay-over time could still be cut down. Citing as an example, a process employed by his company, Mr. Huff showed how the repaint operation can be completed within two days.

Turning his attention to the upkeep of motor-vehicle appearance, which he feels is generally neglected, Mr. Huff stressed proper housing, the installation of power washing machines, and the use of non-injurious materials for washing. A motor truck is a "moving billboard," he pointed out, and a well-groomed fleet can do much in advertising the smartness and efficiency of the organization it represents.

DISCUSSION

There was general agreement that it is worth real money to keep up the appearance of trucks – that good looks have considerable advertising value.

The advantages of porcelain-enamel signs over lettering and decalcomania were stated by W. A. Taussig. The vehicle is not tied up for any appreciable time for attachment of signs, he said, and if the signs are not hit by a hammer or flying stone their appearance remains good for a much longer period. Their cost is about twice that of decalcomania.

Porcelain signs give better service, said Mr. Preble, if the porcelain is shaded to bare metal near the bolt holes, and if washers of soft material are used.

Mr. Glynn told of a new water-type of decalcomania that has better life than the older varnish-type, and that is easier to apply. Further, he said, it is less difficult to place a new decalcomania over an old one.

Mr. Ray commented that the matter of garaging in relation to maintaining truck appearance depends upon the location of the fleet in respect to climate. In the South, he stated, it may be possible to house the equipment in the yard and thus save more than the cost of additional paint jobs required by not building a garage.

In keeping with the Society's 35th Anniversary Meeting, Mr. Winchester at the close of the session gave an interesting review of SAE growth in the T&M field during his long membership in the Society, touching on many of the interesting personalities who have helped solve the industry's problems.

FUELS & LUBRICANTS SESSIONS

Chairmen

J. B. Macauley, Jr. **B. E. Sibley**

Raising moot points by the score, the six papers presented at the Fuels and Lubricants Sessions loosed a flood of controversial discussion. Thermodynamics experts found themselves closer to agreement on heat losses at the end of debate at the first session. Following papers on small engines for testing oils, oil and fuel for severe engine conditions, and an instrument for measuring piston temperatures continuously, discussers streamed to the platform to voice their agreement or dissent in the final session.

The Effectiveness of the Burning Process in Non-Knocking Engine Explosions **– LLOYD WITHROW and WALTER CORNELIUS, Research Laboratories Division, General Motors Corp. (Presented by Dr. Withrow)**

"COMBUSTION was found to be approximately 81% effective in five different explosions which were recorded by means of high-speed motion pictures and pressure cards while running the engine on iso-octane and benzene," the authors revealed. The term, "81% effective," they explained, means that, according to modern thermodynamic data, only 81% of the liberated heat energy is accounted for by the pressures observed during combustion; in other words, 19% of the liberated heat energy is apparently lost from the working fluid.

The flame-picture and pressure data, together with the Hottel thermodynamic charts, they said, make possible a comparison of the actual rate of inflammation of the charge with the rate of combustion required by the thermodynamic analysis for developing the observed pressures. These two rates of combustion, they continued, are approximately equal during the inflammation of the first 10% of the weight of the charge and during the inflammation of the last 50%. They differ markedly, they pointed out, when the actual rate of inflammation is a maximum, and this value is attained in the present engine when from 25 to 40% of the weight of charge is burned.

As the actual rate of inflammation of the charge reaches and passes through its maximum value, they went on, most of the 19% of the liberated heat energy that is not accounted for at the end of the burning period disappears from the working fluid. The authors showed that the apparent energy losses occur in time intervals equivalent to from 2 to 7 crankshaft deg in the five explosions studied. Flame pictures were displayed that showed that the intensity of the afterglow radiation increases sharply during the period in which the apparent energy losses occur.

The authors concluded that the data presented indicate that it may be possible to increase the effectiveness of the combustion process in an engine operating under non-knocking conditions. The chief hindrance to these advances, they averred, is ignorance about the phenomena occurring during combustion which can be surmounted only by better-chosen and better executed investigations.

DISCUSSION

Chairman Macauley announced that the Meetings Committee had requested that no notes be taken or reports published on the first two papers to be read at the session.

These papers are: "Volatility Decreases and Availability of High-Knock-Rating Aviation Fuels," by D. P. Barnard, Standard Oil Co. (Ind.) and R. W. Cragin, M. W. Kellogg Co.; and "Some Economic Aspects of Aviation Fuel Volatility," by Will D. (Billy) Parker and R. C. Alden, Phillips Petroleum Co. They were presented by Messrs. Cragin and Alden respectively.

Confirmation of some of the findings of Messrs. Withrow and Cornelius were reported from several laboratories in discussion, and attempts were made to reconcile the differences in the values of energy loss obtained by the authors with those reported by other investigators.

Pictures of combustion taken by Schlieren photography were displayed by Dr. A. M. Rothrock, National Advisory Committee for Aeronautics. He pointed out that the zones of temperature gradients photographed in his pictures check very well with the combustion zones indicated in the authors' photographs.

C. Fayette Taylor, Massachusetts Institute of Technology, quoted results of a similar investigation conducted at M.I.T., in prepared discussion which was read in his absence by H. K. Cummings, National Bureau of Standards. Prof. Taylor's first slide showed the ratio of indicated mean effective pressure to "theoretical" mean effective pressure for a large number of engine cycles taken from a CFR engine. He defined theoretical mean effective pressure as the mean effective pressure computed by means of the Hottel thermodynamic charts, assuming that: the weight of fresh charge is the same as that measured for the corresponding engine cycle; the fraction of residual gases is the same as that estimated for the actual cycle; and that combustion is instantaneous and equilibrium is maintained at all points on the expansion stroke.

"It is very interesting to observe," he declared, "that the ratio of indicated mean effective pressure to theoretical mean effective pressure is of the same order of magnitude as the 'effectiveness of combustion' measured by Messrs. Withrow and Cornelius." Prof. Taylor also drew attention to the small variation of the ratio of indicated mean effective pressure to theoretical mean effective pressure over the considerable range of fuel ratios, compression ratios, and inlet temperatures employed in the investigation.

Noting that the authors' value for heat loss of 20% is considerably higher than the 6% given in three published references, Prof. L. C. Lichty of Yale University endeavored to reconcile the difference. Announcing that he was the author of one of the references, he pointed out that the 6% heat loss was obtained for an engine running at maximum power which is obtained at about 2500 fpm piston speed, whereas the heat loss of 20% reported by Dr. Withrow was taken at 900 rpm engine speed. To clarify his explanation he plotted a curve on the blackboard of heat loss versus piston speed which showed 100% loss at zero speed, 20% loss at 600 fpm, and 6% loss at 2500 fpm.

Prof. Lichty also questioned the authors' use of a hypothetical process for the evaluation of heat loss, arguing that heat loss depends upon the path of the actual process which must be followed for heat-loss evaluation. By following the path of the actual process, which he traced on the blackboard, Prof. Lichty reported that he had arrived at a total heat loss of 28% as compared with 20% obtained by the authors for one of the cases in their paper.

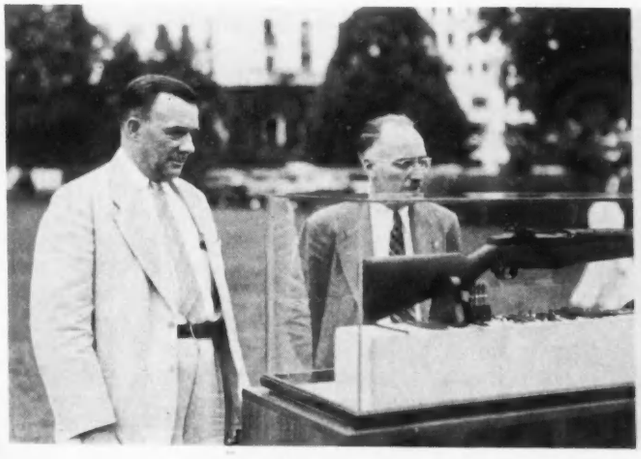
In reply, Dr. Withrow confirmed Prof. Lichty's statement that the data presented had all been taken with the engine running at 900 rpm. He reported that, when the engine was run at 2000 rpm, the heat loss was cut approximately in half. He then reviewed the sources of error that he believes can throw off the heat balances and explain some of the differences in results.

The Use of Small-Scale Single-Cylinder Engines for the Evaluation of Motor Oils – **A. O. WILLEY and C. F. PRUTTON, The Lubri-Zol Corp. (Presented by Mr. Willey)**

SMALL-SCALE single-cylinder engines can be used advantageously for preliminary investigations of the service properties of oils when closely controlled testing procedures are used and when the tests are properly tied in with full-scale block tests and field experience, the authors disclosed. They explained that the accurately controlled conditions are subjected to arbitrarily selected factors chosen to simulate and accentuate the specific type of service conditions under investigation. Displaying a slide showing a bank of prototype single-cylinder liquid-cooled engines used for this purpose – each 2⅝ x 2½ in. bore and stroke, 2½ hp at 1800 rpm – the authors explained that the cylinder blocks were obtained from the same foundry heat to insure uniformity of metallurgical conditions and that very careful control of all other replacement parts is maintained.

They contended that the older basic items of specifications are

Snapped About the Meeting



B. E. Sibley and C. M. Larson

W. S. Bennett and F. P. Hall, Jr.

inadequate for evaluating motor oils in terms of present-day refining methods and engine requirements, and described how the small-scale engines are used to evaluate such properties as detergency, ring sticking, varnish formation, and corrosive tendencies. Simplified laboratory tests for oxidation, corrosion, and other service properties of oils, they claimed, do not correlate sufficiently well with service results to make them dependable as a means for predicting lubricating characteristics in an engine.

The diversified requirements of present-day engine operation, the authors concluded, make it impossible to predict that a motor oil showing satisfactory properties in certain individual respects will be equally satisfactory for all requirements.

DISCUSSION

Parallel experience with small single-cylinder test engines, used to investigate the lubrication of automobile engines, was reported in the prepared discussion of Prof. H. A. Everett, The Pennsylvania State College, read to the session by Chairman Sibley. "Our success," he explained, "has been predicated definitely on complete control of the following vital factors: temperature of crankcase oil; provision for controlled crankcase ventilation; temperature of cylinder head and barrel; control of air-fuel ratio; reasonable mechanical similarity to full-scale units; operation in batteries of six units; and proper catalyst and anti-catalyst. When these factors are correlated correctly to the service performance of the full-scale engine under consideration," he continued, "a technique of operation can be developed which will parallel closely the engine deposits, wear, and oil punishment which will occur in the full-scale engine. This technique must include means for adjusting the experimental data, particularly for carbon deposition, varnish or lacquer deposition and oil punishment, to allow for variations in the amount of oil consumed in the test. "Although in general agreement with the authors," he said, "we handle some items differently, such as determination of wear characteristics by the analysis of the crankcase oil for iron contamination and the use of a small air-cooled engine."

The importance of the closest possible control of oil temperatures and consumption in small single-cylinder test engines was underscored by the next discusser, C. G. A. Rosen, Caterpillar Tractor Co. He added that his company was cooperating in the development of an engine with provision for such close control. He contended that the apparent lack of agreement among various laboratories on corrosion tests for compounded oils can be explained by the differences in the temperatures of the oils tested. Single-cylinder engine tests, he declared, are useful generally as a "go or no-go gage" and are especially useful in measuring the life remaining in the oil after a crankcase drain. He then asked Mr. Willey for further data on oil consumption.

Oil consumption of the single-cylinder engines during the first 30 hr is fairly high, after which time it levels off, Mr. Willey told Mr. Rosen. He then presented additional data to show that the oil consumption is controlled "within reasonable differences." To further questioning by Mr. Rosen who was impressed by these figures, Mr. Willey explained that consumption was taken at 8-hr periods over the entire operating range. Careful control of operating conditions such as is exercised in honing cylinders and fitting rings, contribute more than anything else to the control of oil consumption obtained, he pointed out.

Replying to a question of H. R. Wolf, General Motors Corp., Mr. Willey revealed that non-leaded fuels were used in his single-cylinder engine tests and that comparative runs on leaded and non-leaded fuels indicated no difference in results within the limits of the test conditions.

Severe Duty Engine Conditions as Related to Oil and Fuel – C. M. LARSON, Sinclair Refining Co.

"ALTHOUGH over 200 patents were issued for addition agents for oils and fuels in 1939, the final Utopian addition agent for present-day needs for clean engines is still on the proving ground in truck, bus, and tractor operators' equipment," Mr. Larson contended. His paper brought out the intensive study being given the oil and fuel problem caused by severe-duty engine conditions, as affected by high piston-ring groove and valve-guide temperatures and high crankcase or oil circulating temperatures.

"The general feeling is," he reported, "that, regardless of any changes in engine design that might momentarily simplify lubrication problems, the output of engines will be increased to the limits set by the lubricants." For this reason, he continued, it is desired to develop better oils so that performance can be increased, yet to limit the types of oil necessary to a minimum.

Noting that engine performance, maintenance, and life are today a problem of severe-duty engine conditions, he showed that severe conditions generally are measured in terms of high power output. Such operations, he explained, have brought about high piston-ring-groove and valve-guide temperatures which greatly increase ring and valve sticking tendencies.

In the case of some high-speed passenger-car engines and some overloaded truck and bus engines, Mr. Larson pointed out, ring sticking is not a problem, but high crankcase oil temperatures cause excessive oxidation resulting in varnish on piston skirts and overhead valve mechanism. Time between crankcase drains, alloy-type bearings, and blowby contamination, he specified, all relate to the severity of engine conditions.

The stability of motor oils is particularly difficult to evaluate, he explained, since the aging condition prevailing in the engine is subject to constant change and differs from one engine to another.

DISCUSSION

The beneficial effects of loose mossy tin in the crankcase were brought out in prepared discussion by Prof. Everett, also read by Chairman Sibley. He reported that the viscosity increase, naphtha insoluble, and chloroform-soluble characteristics of the used oil were reduced by about 25% as compared with those present without the tin. Also, he continued, the neutralization number was reduced 20% and the varnish deposits were reduced by one-third. He corroborated Mr. Larson's statements, that "SAE 30 oils are much more stable than SAE 10 oils" of the same crude and refinery treatment.

To correct any impression that Wright Aeronautical Corp. specifies compounded lubricants, A. L. Beall of that company averred that such was not the case, adding that "we merely tolerate them in certain cases."

Reading from written discussion Dr. U. B. Bray, consulting petroleum technologist, challenged certain of Mr. Larson's inferences and conclusions. "The concept of taking top ring temperatures as a yardstick for detergency requirements and crankcase temperatures as an index of anti-oxidant requirements," he opined, "is not correct from either the standpoint of theory or actual engine experience." Citing examples to back his points, he contended "that the conclusion that piston temperatures need not be considered in determining the anti-oxidant requirement is erroneous and apt to be misleading," and the opinion that crankcase oil temperatures need not be considered in estimating detergency requirements "is not correct." Detergency and oxidation requirements should be viewed concurrently, he summarized, and both piston and crankcase temperatures should be taken into account in studying both requirements.

One important factor which Mr. Larson did not mention, he pointed out, is the oiliness or lubricating ability of the oil. He then cited cases where piston lacquering and crankcase sludging have been reduced materially by adding a certain type of oiliness agent which "has only slight detergent and perhaps no anti-oxidant properties."

SAE in National Defense

(*Continued from page* 19)

Probably the most important of these recent measures was the action of the President in reviving the Advisory Commission of the Council of National Defense, legally authorized in 1916 during our last great preparedness drive in time of peace. Of this advisory group, Mr. Knudsen and Mr. Stettinius, both distinguished members of the Society, will be most in contact with us in the armed forces—Mr. Knudsen for coordination of production of finished products, and Mr. Stettinius for raw materials. As explained by the President, the War and Navy Departments will place their own orders, after consulting with the commission, and it will then be the duty of the commission to see that materials are supplied to munitions plants, production schedules maintained, and other elements for orderly manufacture made available as

(*Continued on following page*)

Replying to Dr. Bray's charges, Mr. Larson stuck to his guns, contending that, from a practical operating standpoint, his methods do the job.

G. L. Neely, Standard Oil Co. of Calif., stressed several of Mr. Larson's points in his prepared discussion. Noting a growing tendency to judge the performance of lubricants by inspections obtained on samples of the used oil, he emphasized that "the only reliable criterion of the performance of a lubricating oil is its influence on engine condition, and data in this regard can be obtained only by disassembling and inspecting the engine." The fact that these used-oil inspections are influenced greatly by refining methods and type of crude used, the presence of additives, and the operating conditions of the engine, he charged, makes their use very unreliable, particularly when the characteristics of the oil involved are not well known.

Further data on addition agents were contributed by Mr. Wolf who read from written discussion. In the high-speed heavy-duty diesel engine, he pointed out, the proper combination of oxidation inhibitor or anti-oxidant, and a suitable detergent or dispersion agent, is required. The oxidation inhibitor, he explained, is needed to retard oxidation of the lubricant in the crankcase; the detergent, to control the contamination of the crankcase lubricant by products of incomplete fuel combustion and decomposition of excess lubricating oil in the combustion chamber, and to prevent the formation of deposits that may interfere with engine operation. He added that heavy-duty gasoline truck and coach engines also require a somewhat similar balance between inhibitor and detergent. Such heavy-duty crankcase lubricants, he suggested, may be the best commercial solution of the problem of securing a single crankcase lubricant for all types of internal-combustion engines, even though they are not required for the less severe types of passenger-car service.

Results of tests on compounded lubricants made in his company's laboratory were reported by F. L. Miller, Standard Oil Development Co., at this point. He drew attention to points of difference with other data presented previously at this session.

Referring to Mr. Larson's comparison of oil durability, F. G. Shoemaker, General Motors Corp., emphasized that the GMC diesel test is not an acceptance test like the others, but a destruction test in which failures are expected. It therefore is very stringent, he explained.

In reply Mr. Larson agreed that the GMC diesel test was not strictly comparable with the others adding, however, that the comparison "charted a starting point."

***An Instrument for the Continuous Measurement of Piston Temperatures*—A. F. UNDERWOOD and A. A. CATLIN, Research Laboratories Division, General Motors Corp. (Presented by Mr. Underwood.)**

THE problem of developing an instrument for the continuous measurement of piston temperatures by the thermocouple method can be divided into three parts, the authors announced:

1. The measuring instrument or instruments necessary.
2. The installation of the thermocouples in the piston.
3. The necessary electrical circuit connecting the two.

After reviewing the principle of operation of the potentiometer method of reading temperatures, they described the standard light-beam galvanometer selected for use with the intermittent contacts. The sensitivity of the galvanometer, they explained, is controlled by means of a variable-ballast resistor connected across its terminals. A multiple switch, they said, makes possible the continuous measurement of one temperature or the intermittent measurement of several temperatures. They illustrated with slides how the thermocouple circuit closed at the bottom of each stroke and how, with the galvanometer as an indicator, it is possible to balance the voltages and read the temperatures as in an ordinary instrument. Silver contacts are used, they said.

Test data obtained with the instrument presented by the authors include temperature gradients of both aluminum and cast-iron pistons; the effect of load variation on piston temperatures; and the effect of spark advance on piston temperature.

They announced that a production engine fitted with the final design of the instrument has been run 25,000 miles at 60 mph on a dynamometer with no attention or adjustments, and that a test-car installation has shown that measurements can be made continuously on the road.

DISCUSSION

Called on in quick succession to discuss Mr. Underwood's paper, H. K. Cummings, National Bureau of Standards; A. W. Pope, Jr., Waukesha Motor Co., and Mr. Rosen, contributed experience with similiar instrumentation that indicated the adaptability of Mr. Underwood's apparatus to high-speed work and emphasized the possibilities of the instrument for detonation work as well as lubrication work.

Pointing out that, in the calibration run described by Mr. Underwood, both silver contacts were in the iron wire whereas, in the actual set-up of the instrument in the piston, one contact was in the iron wire and one in the constantan wire, Dr. A. M. Rothrock, National Advisory Committee for Aeronautics, wondered whether this difference would affect the accuracy of the calibration. In reply, Mr. Underwood told him that the calibration had been checked with both wiring arrangements, and that it made no difference in results.

Mr. Shoemaker reminded that the thermocouple measures the temperature at the point where the metals join, and stressed the need for thermal similarity in the thermocouple circuit.

Presenting data on the variation of piston-head temperature with mean effective pressure for cast-iron and aluminum pistons, C. E. Cummings, The Texas Co., contributed experience with a similar instrument for measuring piston temperatures.

The thin cushion of oil on the contacts has made no difference in the action of the instrument, Mr. Underwood reported in answer to a question by A. G. Cattaneo, Shell Development Co. Evidently this oil minimizes wear of the contacts, he added.

needed. I have read arguments that the commission should have power to control the whole program more or less dictatorially, but such arguments fail to take into account that we are still subject to peacetime laws which specify that certain agencies will procure military equipment and be responsible for its inspection and acceptance. The great contribution which the commission can and will make will be to smooth the way for an orderly execution of the armament program in its purely industrial aspects. The War Department fully realizes that our friends Knudsen and Stettinius are better fitted to cope with the headaches of the production line than are military officers whose main concern is that the finished products will fulfill the military requirements. Our advisers are already on the job in Washington giving their full time to the great task ahead. Personally, I feel that it is a great tribute to the automotive industry that the coordinator for finished products should be an outstanding automobile builder. The production of automobiles typifies so well the true spirit of industrial America – quantity with quality at low costs. A word also about Mr. Stettinius. He was with us for a time on the War Resources Board and we in the War Department formed the highest opinion of his abilities. My own personal feeling is that the President could not have selected a better man for this job.

Many offers of help have been coming to the War Department. Among the first of these was that of your Society. Full cooperation has been promised by your governing council. In making this offer, the council has pointed out that the Society is competent and qualified to assist by:

(1) Handling advisory services by engineering committees;
(2) Acting as liaison between the government and your technical talent;
(3) Providing SAE representatives on government technical committees;
(4) Developing standards and engaging in research as required.

Pioneering by SAE

With reference to standardization and research, the various committees of the Society have always pioneered in the advances for which the automotive industry is distinguished. The benefits of these activities have, of course, inured to the benefit of the government. Do you remember that astounding feat in the last war when automotive engineers, including J. G. Vincent and other SAE members, threw together the Liberty aircraft engine behind closed doors amid the fumes of tobacco smoke and hot coffee? Truly, this was a distinguished service. Let us now examine a few of the current cooperative projects of the Society.

First, there is the SAE Ordnance Advisory Committee which has collaborated with the Ordnance Department for many years in mechanized equipment problems. That light tank in our exhibit here reflects in no small measure the effectiveness of the work of this group. We believe that it is the best light tank in the world. Is it already obsolescent? Has the current blitzkrieg showed that we need an even better one to maintain our lead in tank development? We even hear of 80-ton tanks. Do we need such monsters or is a smaller tank of, say 30 tons a better solution for us? Can a modern light tank be made with fewer than 22,000 parts? Such matters are being pondered by our development personnel. When the time comes, we confidently expect the Ordnance Advisory Committee to lend its talents to help solve these and other pressing problems. And so also for our other fighting vehicles. Like automobiles for civilian use, they must keep abreast of the times and take advantage of the progress of the mechanical arts.

Then there is the current collaboration with our Quartermaster Corps, which procures cargo and passenger vehicles. I am informed that cooperative projects are already in progress particularly involving simplification of automotive equipment problems through standardization and interchangeability of essential parts and units. With us, standardization is almost a fetish, particularly when we meet the spare-parts problem in the field. This does not mean that a totally different type of vehicle is needed by the Army. Rather, we would like to see the commercial vehicles produced by you every day standardized among manufacturers so as to better meet military needs. Standardization within the industry is peculiarly your problem and I am glad to say that you are making great strides in that direction. There is no need for another Class B truck project. "If war were to come tomorrow," said Mr. Johnson in his address here two years ago, "I assure you we will not begin the search, as we did in 1917, for an ideal vehicle. In time of peace, it is well to experiment toward the ideal. In time of war, we must be practical. We will take the best of our types available and immediately go into mass production."

Of prime importance is the work of the Society on aircraft standards. Already the Aircraft Division of the Standards Committee is revising the standards now in the handbook to meet the needs of the rapidly expanding aircraft industry. I understand that a valuable recent contribution is on aircraft-engine testing methods, which is widely accepted. Then there are the aircraft materials specifications for ferrous and non-ferrous metals, of which 101 have already been issued. Screw thread and spline standards and ignition cable specifications are in course of development. Ball and roller bearings, fuels, lubricants, and many other items are the subject of standardization and research. Needless to say, all of these developments are of importance to the government.

Already the Society enjoys representation and/or cooperation with the principal government agencies having to do with standards and research. These bonds must be continued and strengthened in the busy days which lie ahead.

We hear much these days about the automobile companies going into the aircraft business, and a few days ago Mr. Ford stated that mass production of 1000 airplanes a day is possible. Whether mass production of airplanes on any such scale is practicable is a moot question on which I am entirely neutral. However, there are some very practical current problems affecting the industry as it is actually operating today which are worthy of attention. For example, the choke point right now and for many months to come is engine production of the higher horsepower ratings. Only a year ago we thought it would be airframes if quantity production such as we have at present should be undertaken. It is, of course, known that farming out of engine parts is being extensively employed by the manufacturers. Some of the automobile companies are already participating in this work. The present indications are that several of them will undertake the manufacture of complete engines. What can be done to speed up aircraft-engine production? Here is a very practical problem which Mr. Knudsen will undoubtedly have to face, since the aircraft program for foreign and domestic needs is certainly the outstanding problem now confronting us. For our foreign customers, it is a vital necessity to obtain aircraft as soon as possible if the democracies are to survive. The trouble is that everybody, including the U.S. Government, wants them at the same time. How those thousands of engines are to be produced in the next year or 18 months is a puzzling problem, especially when we hear that the production rate desired is more than 4000 planes a month, which means twice that many engines. The Aeronautical Chamber of Commerce says we should reach 25,000 engines a year from existing sources by the late fall of 1941 – a long way off and not enough to meet the apparent needs. Can our automobile engine firms tool-up and deliver at an earlier date? When they do get into production, will we then find that airframes have again become a choke point?

Machine Tools Are Problem

Complicating the munitions program which we must undertake is the machine tool supply. I believe no one will differ with me when I say that supply of machine tools of certain types will be the limiting factor. Already there have been conferences of government officials with the machine tool builders. It seems not improbable that Congress will authorize licensing and control of exports of machine tools as well as other essentials for munitions production. Nearly half of the money value of machine tools on order is for foreign account. I understand also that certain foreign governments having machine tools on order are diverting them to domestic manufacturers to enable them to undertake munitions orders. Your Society has a vital interest in machine tools as the foundation for production. Has any committee ever studied the best utilization of the equipment now installed, some of which is idle? Can some of it be released for transfer to munitions plants?

Akin to the machine tool problem is the skilled labor problem. Whether there is a shortage of skilled labor – I mean qualified skilled labor – is another of those debatable questions. For the projected armament program, my own opinion is that the required skilled labor will be found. Qualified skilled men may be wrongly located, geographically, but there are efforts by the government which will be intensified to put these men in the proper localities. For a real war emergency, my own speculation is that there would be a shortage. There are only 70,000 toolmakers in the United States and the number is decreasing because of the falling off of apprentice training in recent years. A large percentage of these are in your industry. The attrition rate has been estimated by some students as high as 5%, and the replacement rate at no more than 2%. When you want skilled men for your plants, are you having difficulty in finding qualified men? I will answer my own question by saying that many of my visitors in Washington tell me that it is becoming increasingly difficult to recruit skilled men and that increased production demands will make the situation worse. Of course, it is too late for proper training by apprenticeship for this emergency. It seems to me that the only solution is to dilute the requirements for skilled labor by breaking down as much as possible skilled jobs into semi-skilled components. Effective action of this kind has been taken in some of the aircraft factories and, of course, the automobile factories have long studied it. My thought is that one of your committees might undertake a study of ways and means to dilute skilled labor still more and spread the available supply to the best advantage.

Permit me to make two other observations about skilled labor. The mechanization of the Army and Navy makes it necessary for the armed forces to have skilled men. Here is further competition for the dwindling supply. The second observation is that the level of skill is definitely falling. Unless there is an augmentation of existing apprentice courses and institution of many new ones as a long range investment for the future, the level of skill is bound to fall still further, and with it goes the ability to produce the things making up the American standard of living.

The large appropriations already referred to are for production orders for military equipment. Even these amounts are not large enough for a maximum effort expressed as a four army program. Many essential plants will not obtain contracts on the competitive bidding system. We must continue to look beyond this present program, large as it is, to a possible one even larger, and get the maximum number of essential industries prepared. This can be done by educational orders for plants not executing production orders. Congress has already provided $16,000,000 for this purpose, and the new appropriation is for an equal amount. Such orders are given only for non-commercial military items not normally produced in industry and are mostly in the field of ordnance. We also have another arrangement which permits the purchase of production studies or plans for conversion of plants. I want to suggest that the Society lend its support to the educational orders program. It is not so spectacular as the production program, nor is there much prospect of financial profit, but it broadens the base of prepared facilities and reduces the time element for plants so educated to get into production. I should repeat that this program is for non-commercial items and has no application whatsoever to the thousands of commercial items needed by the Army.

Passing now to another problem of consuming interest, I will refer briefly to strategic materials. We are, of course, self-sufficient in most basic commodities but there are a few which are vital for munitions production and not available as native natural resources. Chief among the fourteen which we classify as such materials are rubber, manganese, tin, chromium, and tungsten. You know, of course, how important manganese is for steel production, yet practically the entire supply comes from other countries. Closing the sea lanes might be disastrous to our whole manufacturing economy.

Material Reserves Essential

The best solution to the threat of possible loss of sources for such materials is to accumulate reserves, a comparable proposition for industry to that of guns and ammunition for the soldiers. We feel that a proper reserve is one year's supply at this critical time in the world's affairs. Congress has already recognized the danger and last year passed a bill authorizing $100,000,000, with $10,000,000 cash, to start off the program. The appropriation has since been increased to $22,500,000. This program will be accelerated and augmented in the next year if the $47,500,000 already requested is appropriated. The stock piles so accumulated belong to the government and will be sold to essential industries if we are ever cut off from the usual sources. You will, of course, agree that this pre-vision on the part of the government is commendable, but the practical thing is that it is doubtful whether the government can ever finance a year's supply. Industry ought to help with this problem by increasing its own inventories of such materials and, for that matter, all other materials where there might be shortages. The Society can help the government by using its influence to prevent re-exportation of strategic materials and by spreading the gospel of conservation. We already have a moral embargo on some of them but we need some effective public opinion to make it effective. It is surprising how much tin was flowing out of this country until the word was passed to the commodity exchanges that they are hampering our reserve policy by selling tin which the government is trying to conserve for our own use. I am glad to report that there is sentiment in Congress (the House has already passed a bill) to license and control exports of essential commodities with fair prospects of favorable action.

Most of you have heard of the Industrial Mobilization Plan, a study of ways and means to implement a war production program. The present program will not require its invocation. The methods of peace should be adequate, accelerated by the coordination which the Advisory Commission will give to the normal processes. However, I want to refer to a basic principle in the Industrial Mobilization Plan which is equally applicable to the present program, and that is the simple proposition that cooperation rather than compulsion accords best with American tradition as the proper way to develop our munitions strength. Compulsion never worked very well in the World War, whereas there are numerous examples of great results from cooperation. Do you remember how the price of steel tumbled from $360 to $65 a ton when the steel industry itself undertook the coordination of steel production? We can count on the Society to cooperate in technical matters. Can we also depend on you to counsel your industry to line up voluntarily in wholehearted support of the government's program? Woodrow Wilson expressed the American idea very well when he said "The highest and best form of efficiency is the spontaneous cooperation of a free people."

Some of your members are reserve officers. To these I offer the counsel that they should brush up on their purely military education and become active in reserve affairs. Some of them might find themselves suddenly asked to help us with their technical knowledge in maintenance and operation of mechanized forces in field maneuvers; others might be requested to go into district organizations to strengthen the staffs for the inspection of materiel to be procured on the current program; others may be needed around the War Department. In fact, a good many young Ordnance reserve officers, some of whom are members, are already on duty. More will be required. The Regular Army will go to 280,000 within the next few months. There is to be no increase of regular officers so that will probably mean additional reserve officers. Before leaving this subject, you might lend your support to the drive for recruits for the Regular Army. The War Department has asked organizations like your own to put a shoulder to the wheel in filling up the Army on the accelerated recruiting program which must be immediately undertaken.

The War Department is working under high pressure to make effective our part in the preparedness drive. We realize that the vital factor is time, the most precious thing in the world, the only thing God measures out second by second. We have a well worked out protective mobilization plan comprising an initial protective force of Regular Army and National Guard to hold the frontiers until we can in a period of four months expand this force to one million. Supplies of essential military materiel for this initial army is the objective. Obviously, you can not get the non-commercial items, guns, ammunition, etc., manufactured in four months. They must be on hand in reserve. Moreover, we have only to recall blitzkrieg methods to realize that the guns for this initial force had better be in the warehouses and not on paper for production during the first year of war. The intelligent use of time now may mean the difference between victory and defeat. Therefore, we must press along at maximum speed to get all the essential things authorized by Congress while we still have the time with the full consciousness that everything done now may turn out to be just the right margin to keep ahead of disaster until an efficient war organization can become effective. I hope that we will have 15 months leeway on this problem. It will take that long to get the guns, ammunition, signal equipment, chemical defense items, and all the other paraphernalia authorized by Congress.

Existing Equipment Orders

A word now about the existing orders. Last year the appropriations for new weapons and equipment were $84,000,000. The current appropriation is $302,000,000. Production is under way on these items but the essential thing is that we are now making every effort to speed up the deliveries to clear the way for the greater program now authorized. The speed-up and the money to make it possible go hand in hand with the new orders to be placed.

The Society can lend aid to the program for new orders in a very effective way. Responsible, well-equipped contractors for munitions orders will be necessary if the program is to click as demanded by the American people. I have heard that responsible manufacturers are sometimes reluctant to bid on government business. You can contribute a great service if you will use every bit of influence you possess to assist us in getting the business into capable hands. Help us to persuade the strong producing companies to bid for our orders.

Time does not permit of any detailed discussion of foreign orders in this country. Suffice it to say that these already total about one billion dollars, about 90% of which are for aircraft. Such orders constitute a complication of our own procurement program. No small part of the duties of the Advisory Commission will be to coordinate these orders with our own. While the pressure is not yet very great on our facilities for military equipment, other than aircraft, my own forecast is that demands will increase, particularly since the Allies have lost heavily in equipment in Flanders and may also lose producing plants by air bombardment. Secondary sources are already being sought in this country, and it may be expected that the tempo of ordnance procurement will be stepped up in the near future.

I hope I have conveyed an overall picture of the great task confronting this country and filled in a few details showing your part in it. For my own part, I am confident that our great industrial structure will stand successfully the impact of a preparedness drive even greater than that of 1916. I am confident that the SAE will be in the forefront as always in its service for the national defense. With the help of industry, the smoking chimneys of our great industrial plants may well prove to be the bulwark of the free institutions on which our civilization is founded.

NEW MEMBERS Qualified

These applicants who have qualified for admission to the Society have been welcomed into membership between May 15, 1940, and June 15, 1940.
The various grades of membership are indicated by: (M) Member; (A) Associate Member; (J) Junior; (Aff.) Affiliate Member; (SM) Service Member; (FM) Foreign Member.

Baltimore Section

EARLE, SHEROD L. (SM) associate mechanical engineer (diesel), U. S. Naval Engineering Experiment Station, Annapolis, Md.

ROWLEY, JOHN F., JR. (A) district manager, Fitz Gibbon & Crisp, Inc., Trenton, N. J. (mail) 4202 Roland Ave., Baltimore.

Canadian Section

OLSSON, JOHN VOSS (J) assistant to automotive engineer, Sun Oil Co., Ltd., 39 Basin St., Toronto, Ont. (mail) 138 King St., E., Oshawa, Ont.

WALTON, WILLIAM RALPH, JR. (M) works manager, Dunlop Tire & Rubber Goods Co., Ltd., 870 Queen St., E., Toronto 8, Ont.

Chicago Section

OSLER, EDWIN JOHN 2ND (A) secretary, Permalux Co., 910 W. Lake St., Chicago.

Cleveland Section

DOEPEL, WALLACE ARTHUR (A) sales engineer, Thompson Products, Inc., 2196 Clarkwood Rd., Cleveland.

GERHAN, C. F. (M) project engineer, Willard Storage Battery Co., Cleveland.

JAMIESON, JAY R. (J) development and research, Mercury Clutch Corp., Cleveland (mail) 1393 E. 219th St.

MASON, CLAUDE R. (A) service manager, B. F. Goodrich Co., Akron O.

MERRIMAN, JAMES C. (J) assistant to service engineer, Thompson Products, Inc., 2209 Ashland Rd., Cleveland (mail) 11916 Shadeland Ave.

POEHLMANN, GEORGE (J) mechanical engineer, B. F. Goodrich Co., Akron O. (mail) Y.M.C.A., 80 W. Center St.

SCHULDT, HERBERT H. (J) dynamometer operator, research laboratory, White Motor Co., 842 E. 79th St., Cleveland (mail) 2200 Prospect.

Dayton Section

SAIA, BENEDICT XAVIER (J) test engineer, Hamilton Standard Propellers, Division of United Aircraft Corp., East Hartford, Conn. (mail) Gibbons Hotel, Dayton.

SCOTT, JOSEPH C. (SM) assistant mechanical engineer, U. S. Army, Air Corps, Wright Field, Dayton (mail) 66 Cushing Ave.

STOUDT, JOHN M. (M) engineer, City of Cincinnati, Division of Heavy Maintenance, Cincinnati, O. (mail) 136 W. McMillan St.

Detroit Section

BARTH, WILLIAM LEONARD (M) engineering representative, Continental Oil Co., Ponca City, Okla. (mail) 370 Townsend, Birmingham, Mich.

DUMAS, PAUL L. (M) manager, customer relations, Packard Motor Car Co., Detroit (mail) 1340 E. Grand Blvd.

ERICKSON, BURTON C. (J) design analysis, Packard Motor Car Co., Detroit.

FRIES, ARTHUR H. (M) assistant chief engineer, Dodge Division, Chrysler Corp., 7900 Jos. Campau, Detroit.

OLDBERG, SIDNEY (M) experimental engineer, Chrysler Corp., Detroit (mail) 787 Harmon, Birmingham, Mich.

PICKARD, EDWIN CHARLES (M) trim engineer, Packard Motor Car Co., Detroit (mail) 2011 Louise Ave.

SCHMIDT, WALTER EMIL (J) engine designer, auxiliary aircraft, Westinghouse Electric & Mfg. Co., 5835 Martin Ave., Detroit (mail) 16524 Cheyenne Ave.

VENDITTY, ANTHONY (A) experimental engineer, Thompson Products, Inc., 7881 Conant, Detroit (mail) 12444 Westphalia.

Indiana Section

BUTTNER, H. J. (M) chief test engineer, Allison Engrg. Division, General Motors Corp., Indianapolis (mail) 5506 W. 15th St.

Kansas City Section

BASSETT, WILLIAM B. (M) district automotive engineer, Sinclair Refining Co., 1907 Grand Ave., Kansas City, Mo.

GALLAWAY, JAMES HUIE (M) territorial manager, Nordberg Mfg. Co., Milwaukee (mail) 700 Ward Parkway, Kansas City, Mo.

Metropolitan Section

ABRAMS, PERCY O. (A) instructor, Stewart Technical School, 253 W. 64th St., New York City (mail) 161 Park Ave., Williston Park, L. I., N. Y.

BROWN, PERRY W. (M) general superintendent, Wright Aeronautical Corp., Paterson, N. J. (mail) 433 Hillcrest Rd., Ridgewood, N. J.

ERSHOV, NICHOLAS N. (A) engineer, technical division, Amtorg Trading Corp., 210 Madison Ave., New York City (mail) 751 St. Marks Ave., Brooklyn, N. Y.

GEDDES, BEN W. (J) lubricant research, Standard Oil Development Co., Elizabeth, N. J.

MATHEY, AUSTIN V. (J) test engineer, Wright Aeronautical Corp., Paterson, N. J. (mail) 120 Maplewood Ave., Maplewood, N. J.

PELIZZONI, WINTON J. (J) mechanical engineer, experimental laboratory, International-Plainfield Motor Co., 1044 S. Second St., Plainfield, N. J.

TYSON, THOMAS (J) test engineer, Wright Aeronautical Corp., Paterson, N. J. (mail) 47 Kingston Ave., Hawthorne, N. J.

VAIDEN, JOHN C. (J) test engineer, Wright Aeronautical Corp., Paterson, N. J.

ZIMMER, AARON S. (J) production research engineer, Hygrade Products Co., Inc., 35-35 35th St., Long Island City, N. Y. (mail) 10105 72nd Ave., Forest Hills, L. I.

Milwaukee Section

HOLCOMB, A. E. (M) sales manager, crane and shovel department, Koehring Co., 3026 W. Concordia Ave., Milwaukee.

MCCULLOCH, ROBERT P. (M) president, McCulloch Engrg. Co., 3227 N. 31st St., Milwaukee.

PERFEX CORP. (Aff.) 415 W. Oklahoma Pl., Milwaukee. Reps: Henricks, G. B., sales engineer; Lindemann, Herbert E., vice-president; Sara, Joseph E., sales department.

Northern California Section

SILVA, EUGENE E. (SM) junior engineer, U. S. Forest Service, 760 Market St., San Francisco (mail) 5300 Trask St., Oakland.

Oregon Section

LEATHERMAN, J. A. (A) president, Leatherman Oil Co., Portland, Ore. (mail) Route 4, Box 1341.

Philadelphia Section

MAY, WALTER M. (J) engineer, Mack Mfg. Corp., Allentown, Pa. (mail) 25 N. 18th St.

Pittsburgh Section

ANDRES, WILLIAM J. (M) development and research engineer, Bendix-Westinghouse Automotive Air Brake Co., 5001 Centre Ave., Pittsburgh.

SAXMAN, ALBERT BYRON (A) carburetor and ignition mechanic, A. R. Platt, 1206 Taylor St., Pittsburgh (mail) 312 N. Euclid.

St. Louis Section

FAERBER, EARL L. (A) engineering and inspection, Sterling Aluminum Products Co., 2925 N. Market, St. Louis, Mo. (mail) 4878 Margaretta Ave.

ZODER, ORREN E. (M) maintenance superintendent, Anderson Motor Service; vice-president, Zoder, Inc., 1516 N. 14th St., St. Louis, Mo.

Southern California Section

CLARKE, P. S. (M) research supervisor, Union Oil Co. of Calif., Wilmington, Calif.

GALLANT, CHARLES J., JR. (M) chief research engineer, North American Aviation, Inc., 5701 Imperial Highway, Inglewood.

HERRING, EARL R. (A) general manager, Kinner Motors, Inc., 625 W. Colorado Blvd., Glendale, Calif.

JENKINS, GEO. ROSS (A) president, Allube Corp., 1726 Standard Ave., Glendale, Calif.

KRUEGER, RUDOLPH ERNEST (J) design layout, Vultee Aircraft, Downey, Calif. (mail) 4931 Eldred St., Los Angeles.

SANDER, C. P. (M) chief engineer, Menasco Mfg. Co., Los Angeles (mail) 1248 W. 81st Place.

SMITH, HARRY EDWARD (A) travelling mechanic, Inland Stages, 740 Kohler St., Los Angeles (mail) 309 E. 56th St.

WILSON, STANLEY ALLEN, JR. (A) service manager, Pacific Airmotive Corp., Union Air Terminal, Burbank, Calif.

Southern New England Section

BACHELLER, KENNETH G. (J) standards department, Pratt & Whitney Aircraft, Division of United Aircraft Corp., East Hartford, Conn. (mail) 157 Whitney St., Hartford, Conn.

BURT, WILLIAM GRISWOLD, JR. (J) development engineer, aircraft division, Fafnir Bearing Co., New Britain, Conn.

DOBROWSKI, HARRY PAUL (J) engineer, Pratt & Whitney Aircraft, Division of United Aircraft Corp., East Hartford, Conn. (mail) 672 S. Main St., Torrington, Conn.

HATHEWAY, EDWIN R., JR. (J) mechanic's helper, Pratt & Whitney Aircraft, Division of United Aircraft Corp., East Hartford, Conn. (mail) 10 High Rd., Newbury, Mass.

HILLES, L. A. (A) sales engineer, aircraft division, Fafnir Bearing Co., New Britain, Conn. (mail) 70 Vine St.

RECTOR, WILLIAM R. (J) experimental test engineer, Pratt & Whitney Aircraft, Division of United Aircraft Corp., East Hartford, Conn. (mail) 32 Brewer St.

Syracuse Section

BLACK, PAUL H. (M) assistant professor, machine design, Cornell University, East Sibley, Ithaca, N. Y.

Washington Section

BERNHARDT, IRWIN H. (M) vehicular supervisor, Continental Baking Co., 630 Fifth Ave., New York City (mail) 1201 Juniper St., N. W., Washington.

NURNEY, JAMES R. (A) district manager, S. K. Wellman Co., 1381 E. 49th St., Cleveland (mail) 1101 Vermont Ave., N. W., Washington.

PARKINSON, CLAUDE C. (A) Carter Bros., Inc., 2924 W. Marshall St., Richmond, Va.

PASS, HERBERT RALPH (J) junior engineer, National Advisory Committee for Aeronautics, Langley Field, Hampton, Va. (mail) 2105 Kecoughtan Rd., Apt. 51B.

Outside of Section Territory

BRACE, R. LYLE (A) president, Brace Process Corp., 418 N. Willow Rd., Evansville, Ind.

CASEY, EARL L. (A) travelling mechanic, Geophysical Service, Inc., 1311 Republic Bank Bldg., Dallas, Tex.

DARROUGH, MAX CECIL (A) owner, Max Darrough Garage, 14 N. W. Seventh, Oklahoma City, Okla.

KING, THOMAS D. (A) industrial salesman, Shell Oil Co., Inc., Dillingham Bldg., Honolulu, T. H.

MAY, PAUL M. (M) testing engineer, Aviation Mfg. Corp., Lycoming Div., 1515 Park Ave., Williamsport, Pa. (mail) 343 W. Fourth St.

MEGRATH, GEORGE WM. (J) mechanic, Mid Way Garage, Osterville, Mass. (mail) Reading, Vt.

Foreign

HASEGAWA, MASAMITI (F M) president, Society of Automotive Engineers of Japan, 1-8 Marunouchi, Tokyo, Japan.

APPLICATIONS Received

The applications for membership received between May 15, 1940, and June 15, 1940, are listed below. The members of the Society are urged to send any pertinent information with regard to those listed which the Council should have for consideration prior to their election. It is requested that such communications from members be sent promptly.

Baltimore Section

NIGHTINGALE, ROBERT G., project engineer, The Glenn L. Martin Co., Baltimore.

Buffalo Section

ROHAS, RODERIQUE WILLIAM, tire design, Dunlop Tire & Rubber Corp, Buffalo.

Canadian Section

GEROW, FRANK TRAVIS, The White Co., Ltd., Toronto, Ont., Canada.

HOOVER, WALTER SCOT, managing engineer, Canadian Car & Foundry Co., Ltd., Montreal, Que.

POLLARD, HAROLD, consulting engineer, at present with Royal Canadian Air Force, Toronto, Ont.

RAE, ALLAN, sales and service, A. Schrader's Son, Division Scovill Mfg. Co., Inc., Toronto, Ont.

Chicago Section

BENNETT, JACK OLEN, research engineering, United Air Lines Transport Corp., Chicago.

CRAPPLE, JOHN WILLIAM, development engineer, Hoof Products Co., Chicago.

HANNEMAN, WALTER M., research engineer, Illinois Tool Works, Chicago.

TARTER, HENRY G., project engineer, Bendix Products Division, Bendix Aviation Corp., South Bend, Ind.

WILLOCK, THOMAS P., salesman, Studebaker Sales Co. of Chicago, Chicago.

ZIEGLER, EARL EDWARD, research engineer, Standard Oil Co. (Ind.), Whiting, Ind.

Cleveland Section

PORTER, GEORGE H., III, manager and metallurgist, The George H. Porter Steel Treating Co., Cleveland.

RICHARDSON, WILLIAM HALL, assistant general sales manager, The Timken Roller Bearing Co., Canton, Ohio.

WRIGHT, JOHN D., secretary, Thompson Products, Inc., Cleveland.

Dayton Section

BOSLER, THEODORE C., engineer, Allison Engineering Division, General Motors Corp., Dayton.

PARMAKIAN, LEVON, mechanical engineer, Wright Field, Dayton.

YOUNG, ROBERT H., production engineer, The Randall Co., Cincinnati, Ohio.

Detroit Section

HIRSCH, F. PETER, consulting engineer, Aeroquip Corp., Jackson, Mich.

LICHY, CHARLES M., metallurgical engineer, Jones & Laughlin Steel Corp., Detroit.

LONG, CARLYLE RICHARD, vice president and sales manager, Motor Valve & Mfg. Co., Marine City, Mich.

MACPHERSON, CARL D., sales promotion, Gar Wood Industries, Inc., Detroit.

SCHULZ, T. R., chassis designer, Packard Motor Car Co., Detroit.

STRATTON, CARL E., Detroit sales representative, Harrison Radiator Division, General Motors Corp., Detroit.

VAN DYK, EDGAR J., dynamometer test operator, General Motors Corp., Detroit Diesel Engine Division, Detroit.

WICKHAM, MONT, DR., president, General Materials of Michigan, Inc., Detroit.

Indiana Section

GADDIS, WILLIAM C., local manager, Anaconda Wire & Cable Co., Anderson, Ind.

Metropolitan Section

HEYER, WILLIAM T., shop instructor, Greenwich Country Day School, Greenwich, Conn.

JACKES, HERMAN DOUGLAS, JR., senior test engineer, Wright Aeronautical Corp., Paterson, N. J.

JEWETT, CHARLES S., test engineer, Wright Aeronautical Corp., Paterson, N. J.

KOREMANN, FREDERICK W., development engineer, Morganite Brush Co., Inc., Long Island City, N. Y.

LUNDELL, ARNOLD W., instructor, Delehanty Institute, New York.

MCCARTHY, JOSEPH P., secretary, C & C Sales Corp., New York.

MCELGIN, JOHN V., experimental engine tester, Wright Aeronautical Corp., Paterson, N. J.

MILLER, CONRAD, sales engineer, The Belflex Corp., Toledo, Ohio; mail: 311 Palisade Ave., Yonkers, N. Y.

MOFFETT, GEORGE H., technical advisor, The Intercontinent Corp., New York.

OGG, ROBERT S., instructor, Stewart Technical School, New York.

POPPER, CHARLES, associate engineer, Automatic Turbine Drive Co., Inc., Providence, R. I.; mail: 514 West End Ave., New York.

SCHUMACHER, GUSTAV A., owner, Schumacher Motor Service, Yonkers, N. Y.

SMITH, HARRY A., chief Diesel theory instructor, Delehanty Institute, New York.

VAN BLERCK, JOSEPH, JR., secretary, Boat Engines, Inc., Long Island City, N. Y.

ZWICKER, VERNON M., experimental engine tester, Wright Aeronautical Corp., Paterson, N. J.

Milwaukee Section

FROMM, W. H., JR., sales engineer, The Dumore Co., Racine, Wis.

WOTHE, ARMAND W., experimental engineer, Wisconsin Axle Division, Timken Detroit Axle Co., Oshkosh, Wis.

New England Section

BIRD, JOHN R., vice president and treasurer, Power Research Corp., Boston.

GABRIELSON, SAMUEL I., student engineer, General Electric Co., Lynn, Mass.

Northwest Section

HUNDSDORFER, GEORGE A., vice president, Grant Auto Electric, district representative, Ready-Power Sales & Service, Seattle, Wash.

Philadelphia Section

ALEXANDER, NELSON E., test engineer, The Atlantic Refining Co., Philadelphia.

SCHARFENBERG, C. A., truck engineer, Mack Mfg. Corp., Allentown, Pa.

SEMPLE, GEORGE PHILIP, student, Princeton University, Trenton, N. J.

Pittsburgh Section

HOPPENSTAND, DAVID, president, Hopkan Rivet Co., Mechanical Laboratories, Inc., Pittsburgh.

St. Louis Section

KAPPS, MARION HOFFMAN, research engineer, Carter Carburetor Corp., St. Louis, Mo.

Southern New England Section

GRUMMAN, EUGENE VICTOR, chief Diesel instructor, Delehanty Institute, New York; mail: 341 Maplewood Ave., Bridgeport, Conn.

KONGSTED, LUDVIG P., research engineer, American Bosch Corp., Springfield, Mass.

SKOGLUND, VICTOR J., project engineer, Pratt & Whitney Aircraft Division, United Aircraft Corp., East Hampton, Conn.

Southern California Section

ATWOOD, J. L., vice president, North American Aviation, Inc., Inglewood, Calif.

BEGLEY, DON, branch manager, Hertz Drivurself Stations, Inc., Los Angeles.

DODSON, WILLIAM S., service manager, Ruffner & Ruffner, Lompoc, Calif.

DOLAN, ALBERT J., engineering representative, Consolidated Aircraft Corp., San Diego, Calif.

FURRY, FRANK W., junior planning engineer, Lockheed Aircraft Corp., Burbank.

MERWIN, EDWIN D., assistant in education office, Douglas Aircraft Co., Inc., Santa Monica, Calif.

SANDORFF, PAUL EDWIN, engineer, Lockheed Aircraft Corp., Burbank, Calif.

Washington Section

LANE, JOHN J., wholesale manager, Steuart Motor Co., Washington, D. C.

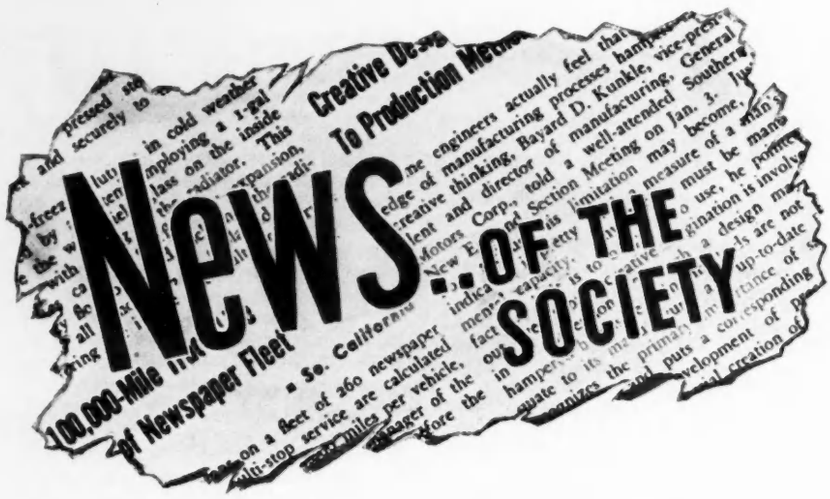
LATROBE, WILLIAM CLAIBORNE, Lieutenant Commander, U. S. Navy, Bureau of Engineering, Navy Department, Washington, D. C.

SYDNOR, JOSEPH TROTH, foreman, Virginia Electric & Power Co., Norfolk, Va.

Outside of Section Territory

MABES, THEODORE, shop foreman, United Transport, Inc., Joplin, Mo.

(*Concluded on page 70*)



Army Officer Explains Effectiveness of Tanks

Canadian

"On the ground as well as in the air, modern warfare is automotive warfare," declared Lt. J. Winchcombe-Taylor of the Canadian Army Fighting Vehicles Training Centre, as he addressed the Canadian Section's May 17 meeting. He was introduced by Norman C. Millman, Oshawa Regional vice-chairman.

Lt. Winchcombe-Taylor was attached to the world's first tank corps, and saw action with it in Flanders and France during the World War. The Germans, he said, first learned the fighting efficiency of the tank from its business end. How great and practical was their appreciation of its potentialities, he added, first was demonstrated by the German Blitzkrieg in Poland, which was made possible by the tank in conjunction with the modern airplane.

The first tanks, he recalled, were capable of a speed of little more than 1 mph, and the fastest of those in action at the close of the great war did a little better than 8 mph under favorable conditions. Some of today's tanks are capable of better than 50 mph, he declared. Differentiation for various services, he noted, has been carried on to the point where Italy has developed tiny one-man tanks and France has huge tanks carrying crews of more than a score.

In one sense, the speaker stated, the origin of the tank far antedates recorded history as it stems from the first attempt of savage man to shield himself. The effectiveness of tanks as a shield is indicated, he said, by the casualties during the first great war. He reported that there were 10,000 British casualties during the assembly before the attack was launched in the third battle of Ypres. At Cambrai, the first battle at which tanks were used in considerable numbers and under favorable conditions, the assembly loss was nil. Further, he said, tanks demoralized the opposing Germans to such an extent that a single tank entering a village miles back of the line resulted in its immediate evacuation by the Germans holding it.

Other figures indicating the qualities of tanks as shields, quoted by the speaker, revealed that British casualties per square mile of battle field were 5300 in 1916, when no tanks were used; 8200 in 1917, when the use of tanks was negligible, except at Cambrai; and just 83 in 1918, when tanks were used in large masses.

The strength of the modern army, said Lt. Winchcombe-Taylor, is largely computed in terms of fire power and mobility, which explains in large measure why, on the ground as well as in the air, modern warfare is automotive warfare. The speaker stated definitely that British tanks have proved themselves in action to be superior to Nazi tanks. He urged, inferentially, that Canada produce tanks in large numbers.

The meeting was attended by a number of staff officers of Canadian Military District No. 2, including Col. A. E. Nash, adjutant and quartermaster general of the District. Col. E. Parsons, officer commanding the Ontario Regiment (tank), and a number of officers were present.

Retiring Section Chairman Marcus L. Brown opened the meeting and introduced his successor, Norman H. Daniel, general service manager, General Motors of Canada, who presided for the remainder of the meeting. On behalf of the Section, Past Chairman William E. McGraw presented a wrist watch to Mr. Brown in grateful appreciation of the service he had rendered as chairman.

How Tanks Were Named

HOW tanks became so named was one of the numerous bits of information Lt. J. Winchcombe-Taylor gave in his talk before the Canadian Section, May 17.

Great secrecy had attended the construction of tanks in England early in the 1914-1918 World War, he said. Because of their size, it was difficult to keep them secret in transporting them by rail to British ships and by ship to France, even when covered by tarpaulins.

At that time, he continued, rumors were current in England that Russian contingents had been landed in the north of Scotland and were being transported to ports in the south of England. It was decided, he said, to capitalize these popular rumors by disseminating the misinformation that there were water tanks under the tarpaulins to supply the supposed Russian troops.

Thus the name "tank" became universally accepted, based on this deliberate misnomer, he declared; stating that these fighting vehicles were originally referred to as "His Majesty's land ships."

His Worship Mayor J. Carl Anderson, of Oshawa, extended a cordial welcome to out-of-town guests.

Harking back more than a quarter-century, Col. R. S. McLaughlin, president, General Motors of Canada, stated that at the first SAE meeting he attended he witnessed maneuvers of armored caterpillar-tread tractors in conjunction with three airplanes. He referred to this as a prophetic demonstration in that in its small way it foreshadowed modern mechanized warfare. Col. McLaughlin spoke in acknowledgment of thanks to General Motors of Canada, host of the Canadian Section's Oshawa meeting.

Sees Great Possibilities For Plastic Airplanes

So. California

"The present and future possibilities of plastic aircraft are practically unlimited," declared Walter Hite, chief engineer, Timm Aircraft Corp., in addressing the San Diego meeting of the Southern California Section, April 19. He spoke of military, commercial and private-plane applications. Mr. Hite's paper was one of four presented; the other three were reported in the June SAE Journal.

The process described by the speaker was developed by the Timm organization. It is known as "Aeromold," and has been used in the fabrication of the Timm Primary trainer, and has been proven by extensive tests to "produce a structure which is lighter in weight and more economical to manufacture than conventional types."

Mr. Hite explained: "The process consists, essentially, of impregnating thin sheets of plywood with a phenolic resin bonder, molding them in a single operation into the desired components, baking the whole in order to attain the ultimate in both bonding and physical characteristics of the phenolic resin, and finishing with a plastic paint. . . . The 'Aeromold' plastic process is largely predicated on the desirable characteristics of plywood, with the elimination of the undesirable characteristics through the use of the phenol-formaldehyde plastic materials."

Recent static tests, Mr. Hite reported, which were conducted on the horizontal tail surfaces of the prototype Timm Trainer, which were loaded to 120% of the design load, showed a maximum deflection at the tips of 1.38 in., with no measurable permanent set when the load was removed. Although no effort had been made to design for minimum weight, since manufacturing economy was the aim, these surfaces were approximately 20% lighter than a comparable all-metal surface, he revealed. Mr. Hite also stated that the bonding material is not sensitive to time, heat, or pressure.

The reduction in weight and increased aerodynamic efficiency resulting from the use of the "Aeromold" process, he said, will permit the design of interceptor types of military planes far superior to any in use today, and these same factors will increase the range and general performance of bombardment type airplanes. In the commercial field, he added, the plastic process undoubtedly will produce an airliner with better performance and carrying capacity, at less cost than any in use at this time.

Mr. Hite feels that the greatest opportunity for development of plastic airplanes is in the private field, where mass produc-

tion of light, small planes is indicated. It is entirely possible, he explained, to mold sparless wings, fixed and movable surfaces, and a fuselage which would be the essence of simplicity because of their few structural members.

Mass-production methods can, then, be easily attained by the use of the plastic molding process, he declared. Tests have indicated, he continued, that several fuselage skins, for example, can be molded at one time with one set of molding equipment, offering potentialities of far exceeding current practices in producing aircraft.

Depicts Use of Polarized Light in Stress Analysis

▪ Detroit

A vivid demonstration of the method of determining stresses in welded parts by the use of celluloid models and polarized light, and a plea for closer liaison between car engineers and welders, by E. W. P. Smith, Lincoln Electric Co., and L. M. Benkert, Progressive Welders Co., respectively, made the joint "Design for Welding" meeting of the Detroit Sections of the SAE and the American Welding Society, May 20, a standout in high-caliber technical sessions.

"Low cost in welding depends to a large extent on the uniform distribution of stress in the part or parts," Mr. Smith declared in his paper "Cost Reduction as Studied by Use of Celluloid Models and Polarized Light." Price reduction may be affected by reducing the dollars and cents cost for a given performance, he said, or by increasing performance for a given expenditure. Therefore, he added, a method that would make possible the quick determination of maximum and minimum stresses of a welded object would be an important step in obtaining welding uniformity.

Using polarized light and celluloid models of stressed parts, the author demonstrated a newly-developed method of eliciting stress values – a method which he feels is a practical answer to the problem. Projecting polarized light through a plastic model and onto a screen, he showed how an X-ray effect is obtained with the stress concentrations appearing in shaded bands on the screen surface. The welder or designer can equalize stress factors by noting the flow of these concentrations, Mr. Smith explained, thereby achieving maximum weight reduction through simplification of design.

Greater performance and lower cost are the result of this new method, the author stated, adding that reflection-type polariscopes for demonstration or comparative studies can be constructed very cheaply.

Touching on the rather "knotty problem" of personal contact between the welding engineer and the automotive-body engineer during the period when new model blueprints are being drawn up, Mr. Benkert urged closer cooperation between the two groups. The welding engineer should be called into car-body conferences, the author feels, just as soon as the body engineer enters the picture. As it is now, Mr. Benkert said, the welding man, summoned when production plans are almost completed and with about a week's time to analyze problems which others have had six months to mull over, finds himself at a great disadvantage.

"I sincerely believe . . ." said Mr. Benkert, "that after the inception of design, if the welding engineer with his broad cost-saving knowledge were consulted as to the feasibility of certain sections that must be joined, that the body engineer, the producer, and the manufacturer of equipment would all benefit."

Tells Advances Made in Truck Gear-Box Design

▪ Northwest

"Other than the substitution of helical gears and of helical gears and sliding clutches for sliding-spur gears to facilitate gear shifting and more quiet operation, there had been little or no improvement in the design of the gear boxes for commercial vehicles for a quarter of a century, until about a year-and-a-half back when two commercial-vehicle five-speed gear boxes were released for production carrying blocker-type synchronizers."

That was Carl D. Peterson's introduction to his paper, "Commercial-Vehicle Gear Boxes," presented before the Northwest Section's May 14 meeting.

Mr. Peterson, who is executive engineer of the Spicer Mfg. Corp., explained that the synchronizers, being of the blocker type, give a gear box in which the changes are very easily accomplished by declutching and applying small hand pressure to the gear-shift lever. Due to the fact that it is not necessary to double clutch when changing speeds in a synchronized gear box using the blocker-type synchronizers, he added, no particular skill is required on the part of the driver so far as gear changing is concerned.

"The blocker-type synchronizer," he explained, "prevents engagement of clutching elements in the gear box by virtue of a series of blocking cams during the time of synchronization. After the synchronizer cones have brought the elements to be engaged to equal velocities, the cams release and permit engagement of the clutching elements."

Mr. Peterson pointed out that in the design of gear boxes their severe service makes necessary the use of extreme care to reduce fluid friction so as to allow the box to operate at as low a temperature as possible. This has been accomplished, he related, by lowering the oil level to a point that allows a minimum of oil shearing and churning by the gears. The gears are allowed to dip to a depth about equivalent to the height of the gear teeth in a cold gear box with cold oil. The oil level will rise some as it warms up. This slight amount of dipping of the gears, he explained, does not take care of the synchronizers, needle bearings, or the bearings of the input and output shafts. To lubricate these points, a gear pump is provided, driven from the countershaft and delivering oil through suitable ducts. Oil going through the pump from sump is properly strained.

This scheme of gear-box lubrication, Mr. Peterson declared, reduces operating temperatures considerably. Fluid friction heat tests of the gear box, he reported, showed that at summer heat the stabilized temperature is approximately 175 F at 200 rpm; this being in the neighborhood of 100 F less than the same gear box with pump disconnected and the oil level carried up to the conventional height, run at the same speed.

In summarizing, Mr. Peterson said: "The gear box best suited for present-day commercial use should embody the following characteristics: light weight, lower cost, synchronized speed changes, low operating temperature, quiet operation, commonly used conventional material, and two auxiliary power take-off openings."

SAE Men Called to Help Government Organize National Defense Program

WHEN the American Eagle screams "Prepare," the U. S. Government calls to SAE members for help.

Individual Society members as well as the Society itself are scheduled for leading roles in the rapidly unfolding drama of national defense. This much is already clear as industrialists, military chieftains and government officials work day and night to complete planning and get production under way in the greatest peace-time preparedness program the United States has ever known. Every list of executives and engineers publicly called to Washington to imple-

ment this huge program is studded with names from the SAE Roster. Every temporarily confidential list of special appointments is loaded with experts long affiliated with the Society and its activities.

Many members in both of these groups have been given leave of absence by their companies to serve the government until further notice; some have completely severed private connections to assume preparedness responsibilities; others are operating from private positions, serving as required.

Leading stars in the SAE galaxy already drafted by Uncle Sam are General Motors' President **W. S. Knudsen,** on leave from the Corporation, and **Edward R. Stettinius, Jr.,** who has resigned as chairman of the board of U S. Steel to fulfill Washington obligations.

Mr. Knudsen is adviser on production of finished products on the Advisory Commission of the Council on National Defense recently revived by President Roosevelt. Mr. Stettinius, likewise a member of the advisory group, is in charge of production of industrial raw materials. This Commission originally was legally authorized in 1916 during our last great preparedness drive in time of peace.

Briefly describing the duties of these two executives, President Roosevelt said of Mr. Stettinius, that his duty will be to see that the factories get all the raw materials they need, and quickly. Taking iron ore in the Mesaba range for example, the President said that Mr. Stettinius would see to it that ore got dug up and shipped down through the Great Lakes to the steel plants, there to be converted into rolled steel or engine blocks.

Mr. Knudsen, he said, will begin his job where Mr. Stettinius leaves off. The raw materials being supplied, he will supervise their manufacture into airplanes, airplane

S·A·E Student Branches

UNIVERSITY OF MICHIGAN

Looking through "Engine Arch" between the Engineering Annex and West Engineering Building on the University of Michigan campus

Data supplied by Fred H. Steuber, University of Michigan Student Branch Field Editor for the SAE Journal. Photograph by Student Branch Chairman E. Dudley Scrogin.

ENJOYING the strategic advantage of being located at the center of the automotive industry, the SAE Student Branch at the University of Michigan, Ann Arbor, is within a few hours' drive of 90% of the entire automobile production of this country.

Although the Branch was not established until 1938, it holds the enviable position of being one of the most active technical societies on the campus. The SAE exhibit was an outstanding feature at the recent Michigan's Union Activities Smoker. On display were cut-away models of transmissions, differentials, carburetors, universal joints, and working models of other automotive parts.

Because of its intimate association with the automotive industry, and through the cooperation of Michigan alumni who are members of the SAE, the Branch's choice of speakers is unlimited. Capacity crowds attend its biweekly meetings which are designed to interest the majority of automotive and aircraft engineering students.

Occasional field trips are made to neighboring automotive plants and it is not unusual for a group of Branch members to attend SAE Detroit Section meetings.

The University of Michigan is one of the oldest technical schools in the United States. It was founded in 1817, when an act "to establish the Catholepistemiad of Michigania" was adopted by the Governor and Judges of the Territory. Originally situated in Detroit, the University was moved to Ann Arbor immediately after Michigan was admitted into the Union as a State in 1837. The first professor of civil engineering was appointed in 1853, and engineering degrees granted for the first time seven years later. The College of Engineering was established as a separate department of the University in 1895.

Michigan ranks third of all engineering schools in the number of alumni included in the current issue of "Who's Who in Engineering," according to an analysis of that book. It is estimated that during the past ten years approximately 20% of the mechanical engineering graduates have gone directly into the automotive field.

(*Concluded on page 74*)

engines, tanks, guns, and other necessary defense products.

Asked by Secretary of the Treasury Henry Morgenthau, Jr., to take over the machine-tool work of the government, Mr. Knudsen immediately held a series of conferences with a defense committee of the machine-tool industry, headed by SAE Member **Clayton R. Burt,** president of the Pratt & Whitney Division of Niles-Bement-Pond Co. As a result of these meetings a machine-tool coordinating committee was set up with Mr. Knudsen as chairman and Studebaker's Board Chairman **Harold S. Vance** as vice chairman.

Ralph E. Flanders, president, Jones & Lamson Machine Co.: **James Gleason,** president, Gleason Works; and **Tell Burna,** general manager, National Machine Tool Builders' Association, are SAE members among those serving with Mr. Burt on the machine-tool industry defense committee.

Morgenthau Names Mead

Concurrent with the late-May announcement by the Treasury Department that the government was obtaining from leading airplane manufacturers permission to spread production of selected types of airplanes and engines over the aviation industry by a licensing program, Secretary Morgenthau appointed a staff of experts led by **Dr. George Jackson Mead,** vice chairman of the National Advisory Committee for Aeronautics.

This group has been transferred to the Knudsen-headed phase of the Advisory Commission. Working with Dr. Mead is **T. P. Wright,** vice president, Curtiss-Wright Corp. Also in this group are **S. D. Heron** and **Edward S. Taylor.** Among other SAE members holding posts with the Advisory Commission are **W. L. Batt** and **A. W. Morton.**

In mid-May a large number of SAE members from all parts of the country joined with other industry experts in a national defense conference with government officials. Among them were: **Lessiter C. Milburn,** Curtiss-Wright Corp., St. Louis Airplane Div.; **John H. Jouett,** Aeronautical Chamber of Commerce of America: **R. W. Millar,** Vultee Aircraft Div., Aviation Mfg. Corp., **C. L. Egtvedt,** Boeing Airplane Co.; **I. H. Kindelberger,** North American Aviation, Inc.; **C. H. Schildhauer,** Glenn L. Martin Co.; **G. M. Bellanca,** Bellanca Aircraft

Applications Received

(*Concluded from page 67*)

MAXWELL, THOMAS AUDLEY, chemist, International Lubricant Corp., New Orleans, La.

TAYLOR, E. L., pilot representative, Guiberson Diesel Engine Co., Dallas, Texas.

ZIIFLE, ROBERT W., inspector of equipment, New Orleans Public Service, Inc., New Orleans, La.

Foreign

MOORE, HORACE EDWARD, factory manager and production engineer, Commonwealth Aircraft Corp., Pty., Ltd., Melbourne, Australia.

OLIVER, WILFRED THOMAS, technical research assistant, Humber Ltd., Coventry, England.

RALPH, CLARENCE JOHN, managing director, L. M. Silver & Co., Ltd., Wellington-New Zealand.

SHAFIK, OSMAN, power station superintendent, Egyptian State Railways, Cairo, Egypt.

Corp.; and **Leroy R. Grumman,** Grumman Aircraft Engineering Corp.

Airplane Production Debated

In May **Henry Ford,** founder of the Ford company and founder member of the SAE, stimulated headlines with the declaration that his company could turn out 1000 standardized airplanes a day "with the counsel of men like Lindbergh and Rickenbacker, under our own supervision, and without meddling by government agencies. . . ."

Although some aircraft manufacturers immediately commented that Mr. Ford's estimate was too optimistic, Mr. Knudsen, who once worked with him, commented: "If Ford says so, he can do it!" **S. M. Fairchild,** president of the Fairchild Engine & Airplane Corp., when asked to comment, replied that anything is possible with enough money, equipment, and personnel. He added that the airplane and engine companies now in the field have developed design and production methods most efficient for the quantities now being produced, but that if greater quantities were needed the existing companies, with proper cooperation from material and parts suppliers, could produce them.

Pointing to the possible manufacture of parts from wood fiber and plastics, as a means to speeding production and reducing costs, Mr. Fairchild said that this method shows great promise. However, he added, equal production increases are needed in the accessories and equipment that make a modern airplane an efficient fighting machine.

It is the opinion of **Glenn L. Martin,** pioneer plane builder and head of the airplane manufacturing company bearing his name, that the American aviation industry can far exceed the production of the German aircraft industry if given a government program and a regular flow of orders. "We can be doing as much in 12 months as Germany has accomplished in the last three years," he said in addressing a group of aviation writers. "Germany is not a nation with the production capacity that we have."

Sloan Gives $100,000

A gift of $100,000 from **Alfred P. Sloan, Jr.,** chairman of the board of General Motors Corp., to the Massachusetts Institute of Technology will make possible the immediate construction of a large addition to the Institute's airplane-engine laboratory to expand research for national defense, Dr. Karl T. Compton, M.I.T. president, announced June 3. Mr. Sloan was a member of the Class of 1895 at the Institute. He has made several visits to Washington to confer with Secretary Morgenthau and other government officials.

Col. Jouett Addresses Forum

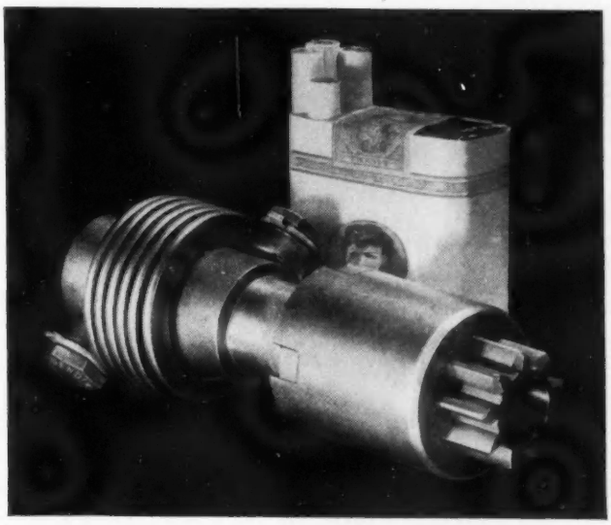
"You cannot get production of planes, engines, or accessories in time to be of value in this defense program merely by dumping public funds into brick and mortar in new localities . . ." was the opinion voiced by **Col. John H. Jouett,** president of the Aeronautical Chamber of Commerce, in addressing the National Aviation Forum in Washington late in May. He stressed his belief that the aircraft industry cannot effectively use skilled labor from other industries (including the automotive industry), and predicted that "any system, other than orderly industry expansion directed by our own air industry leaders will fail—and fail miserably."

Rickenbacker Opinions

When laying plans for the National Aviation Forum, **Capt. E. V. Rickenbacker,** World War ace, and president of Eastern Air Lines, Inc., said, "America's big problem in the air at the present time is manpower. If we have 50,000 planes we must think in terms of 150,000 pilots and 750,000 in ground personnel. In my opinion training college students to fly in light airplanes and then turning them loose without giving them advanced training is a waste of time, effort, and money." At present, Capt. Rickenbacker added, there are only about 8,000 pilots available in the United States who could pass muster under the Army's exacting standards for aviators.

Mooney Sees U. S. as Mediator

Analyzing the role of this country in European affairs, **J. D. Mooney,** GM vice president recently appointed executive assistant to Acting President Charles E. Wilson, in full charge of negotiations involving defense equipment, in a talk before the alumni of the Case School of Applied Science, said that while an isolationist policy would serve our material interests best, we are already conducting an "undeclared economic war"



It's not much bigger than a pack of cigarettes . . . . *but it's about the biggest thing on any car!*

Of course, there are harder-working chassis units—engines, axles, transmissions and the like. But judged on the basis of its contributions to owner *convenience,* can you think of anything bigger than time-proved Bendix Drive?

Forgotten, literally, for months at a time, Bendix Drive cranks the engine times without end. For that kind of service, with so much at stake, isn't it well worth while to provide the best there is?

The Bendix Drive is adaptable to every type of starting control—foot button, clutch or accelerator pedal, dash button or with Startix, completely automatic switch key starting. There is a Bendix Drive especially engineered for every size and type of engine. Specify this approved unit which gives "touch and go" starting, the kind that car owners prefer.

ECLIPSE MACHINE DIVISION
BENDIX AVIATION CORPORATION, ELMIRA, N. Y.

BENDIX *Drive*

on the countries identified as potential enemies. He proposed that this country consider entrance into the war as inevitable, but urged that before we add our strength to the forces that are destroying Europe, "at least we ought to take one last good look at the possibilities of using this strength in the international situation to compel a discussion of the basis for peace.

"Some opportune moment will come," he declared, "when all of the belligerents will welcome the proposals of an armistice by a neutral country.

"Only America with her great economic and potential military strength can act as a mediator and facilitate such a discussion for peace," Mr. Mooney stated.

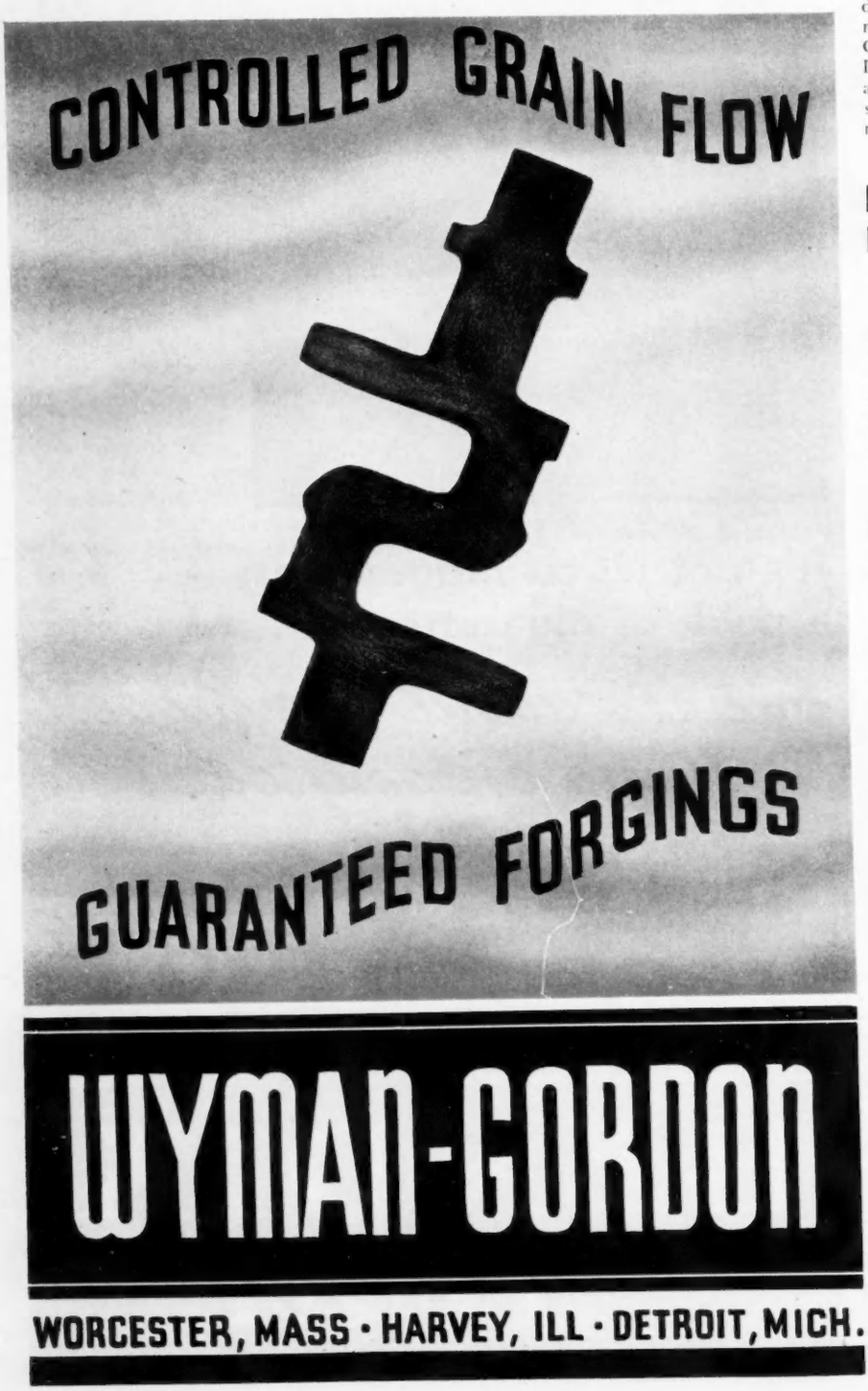
Non-Stop Air-Mail Pick-Up Demonstrated

■ *Pittsburgh*

Air-mail pick-up "on the wing" and the delivery of air-express shipments by parachute, spectacular demonstrations by All-American Airways, were features of the Pittsburgh Section's May 16 meeting, held at the Allegheny County Airport. Members of the Aero Club of Pittsburgh were hosts and, as guides, conducted groups of ten through the air-traffic control tower, the meteorological bureau, and Pennsylvania Central Airlines' shops devoted to airplane maintenance, and the repair of radios, propellers, and engines. A new Transcontinental & Western transport plane was inspected following the tour.

The All-American Airways, with terminals in Pittsburgh and Philadelphia, provides air-mail service to 58 communities not on regular air-mail routes and which do not have adequate airport facilities.

Nearly 100 members and guests of the Section were on hand for the inspection and demonstration. Sixty-four remained for dinner, after which short talks were given by Cliff Ball, president of the Aero Club of Pittsburgh, and Mr. Hancock, assistant manager of the airport, through whose courtesy special facilities were made available for the meeting.



Fleet Operators Attack Problems in Open Forum

■ *No. California*

Open season was declared on a dozen problems important to Pacific Coast fleet operators at the Northern California Section's meeting of June 11. There were no scheduled speakers. Volunteers answered the call to comment as Section T&M Vice Chairman S. B. Shaw, Pacific Gas & Electric Co., read the questions sent in for discussion.

There was general agreement that much valuable information regarding the mechanical condition of a vehicle can be obtained from proper interpretation of used crankcase oil analyses; providing correct sampling procedure.

Closely following was the question of crankcase-oil quality and its relation to cost. The life of a lubricating oil is a function of time and temperature, said one discusser, who emphasized that the initial price of the oil cannot be counted on as an index of performance. Another insisted that the engine itself is the only accurate yardstick. While laboratory analyses indicate the presence of contaminants, he said, the actual engine tells the story on wear as well as the presence of varnish and sludge. The spacing of drain periods to suit vehicle conditions and operating requirements was termed "common sense."

It was brought out that lubricating oils containing additives must be reclaimed with caution because clay and other materials used in some reclaiming processes remove the additives. The general consensus, however, was that the mechanical filtration of oil does not diminish, to any damaging extent, the functions of the additives.

Brake lining came up for discussion, and one discusser said that the operator's goal is the best possible mileage per dollar of brake lining invested, and that this can best be reached by giving careful consideration of the vehicle construction and operating conditions. Other fleet men reported mileage received from brake lining in various types of service.

When the question of safety was introduced comments centered on anti-roll-back devices. Bus men reported that passengers on hydraulic-drive vehicles operating on hills often become alarmed when the vehicle rolls back slightly when starting, and that this is overcome with an anti-roll-back de-

vice. Truck men voiced little interest in this type equipment.

Discussion of fluid drives brought the remark that while it may be the driver's first impression that a vehicle with this type of drive lacks performance, it soon becomes evident that this false opinion results from the lack of customary jerks and irregular acceleration. It was stated that fluid-drive vehicles give better acceleration performance than those equipped with coventional drives. Several of the operators said that engine tuning is more critical on cars with fluid drives, particularly in regard to spark advance through the lower engine-speed ranges. The fuel mileage of passenger cars with fluid drives seem to be about the same as with mechanical drives, according to those contributing remarks.

Chromium-plated cylinder walls brought favorable comments. Decidedly reduced cylinder wear and lower oil consumption were reported by operators having vehicles with chromium-plated cylinder walls. Longer engine and oil life also was credited to the control of crankcase-oil temperature; keeping it in the neighborhood of 180 F.

Other opinions voiced on various topics were: that there is quite a difference between recommended spark-advance setting and actual practice; that over-speeding of engines while descending grades results in many bearing failures blamed to other causes; that rayon tires give a good account of themselves in high-speed operation on smooth, dry roads, but deteriorate rapidly when moisture reaches the cords; that too-lean and unequal mixtures cause piston burning and destruction in some cylinders of engines using butane as fuel; and that operators are experiencing little or no vapor-lock trouble in hydraulic brakes.

Participating in the discussion were: J. M. Mosher, Standard Oil Co. of Calif.; E. C. Wood, Pacific Gas & Electric Co.; S. E. Onorato, Union Oil Co.; E. F. Twinning, Twinning Laboratories; C. F. Becker, Tidewater-Associated Oil Co.; Peter Glade, Purity Stores, and others.

Fleet Lubrication Problems Discussed

■ *Tulsa Group*

On May 3, the student branch of the SAE at the University of Oklahoma were hosts to the SAE Tulsa group. The afternoon session started at 4 o'clock with a paper on "Oiliness" by J. B. Jones, senior student of the university, at the conclusion of which the students made a demonstration of laying down monomolecular (or very thin) film in preparation for oiliness tests.

At the night session, Mr. Petras, manager of maintenance, Southwestern Greyhound Co., presented his paper on "Sludging and Other Lubricating Problems."

Basing his talk on the observations and opinions of operators at Southwestern Greyhound, Mr. Petras touched on such problems as sludging, acidity, carbon, lacquer, and varnish. One of the interesting statements Mr. Petras made was, "although it is quite generally assumed that the formation of lacquer is not apt to occur after the engine has been in operation for several thousand miles, we are not sure. We recently examined some bearings that were covered with lacquer at the end of several thousand miles. The lacquer had obviously coated the bearings after considerable wear had taken place."

CAA Utilizes SAE Aircraft Standards

The Civil Aeronautics Authority, in preparing its Manual 13 on aircraft-engine airworthiness is incorporating forms and material from the SAE aircraft-engine test code, it was revealed by J. T. Gray, chief of the CAA Airworthiness Section, in a letter to R. T. Howe, chairman of the subdivision on aircraft-engine testing forms of the Aircraft Engine Division of the SAE Standards Committee.

Commenting on the Society's accomplishments, Mr. Gray said: "We believe your work along this line has been a valuable contribution to engine testing, and hope that your activities toward standardization and acceptance of testing forms will be successful."

The material being used by the CAA was developed by the SAE Aircraft-Engine Division of the SAE Standards Committee, headed by SAE President Arthur Nutt, and its subdivision on aircraft-engine testing forms, under the chairmanship of Mr. Howe. Permission for its use has been granted to the CAA by President Nutt.

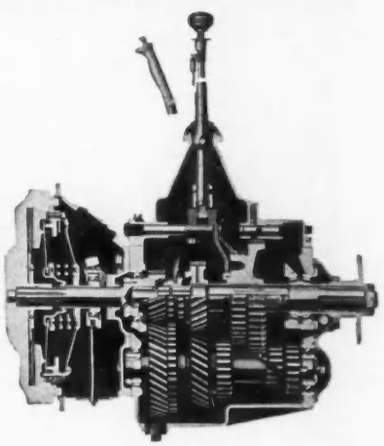
GEARED FOR THE TOUGHEST JOBS

BROWN-LIPE HELICAL GEAR TRANSMISSIONS

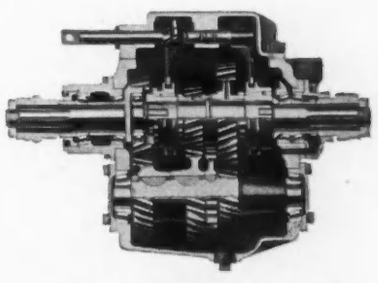
Fleet operation is constantly making new demands for better performance and longer service. So, more truck and bus engineers are specifying Brown-Lipe Transmissions — because they know the rugged dependability of these Spicer products is as old as the industry.

Brown-Lipe Helical Gear Transmissions are engineered and built for years of continuous service on the toughest jobs. They are of balanced design, with lower tooth pressure, greater bearing capacity, minimum shaft deflection, shielded anti-friction bearings and the world's finest precision gears.

For modern transmission equipment that will improve performance, economy and service, check with Spicer. Do it today.



BROWN-LIPE 4-SPEED TRANSMISSION



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Smith Engineer Favors Separate Frame and Body

▪ Detroit

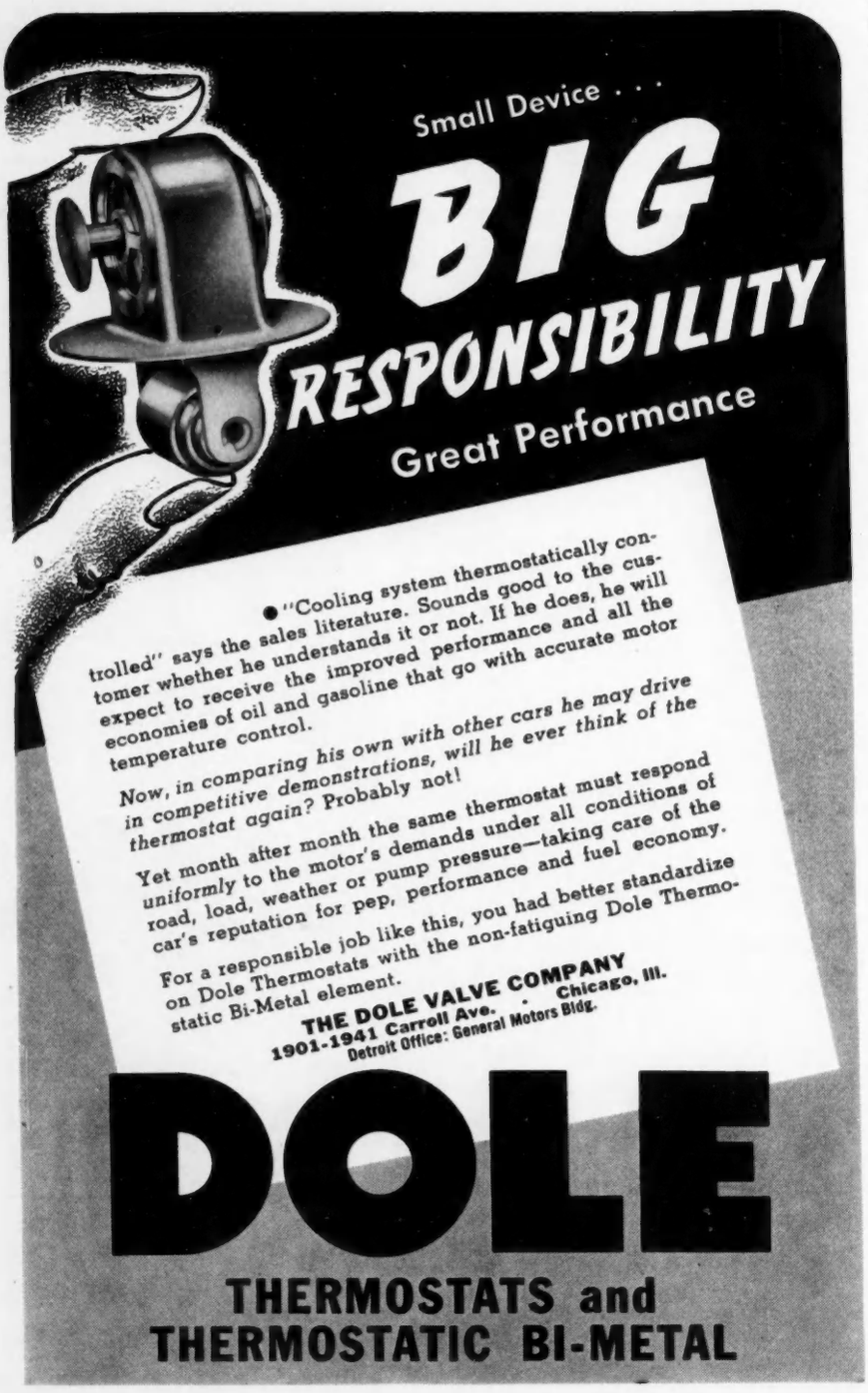
Ride characteristics of unit frame and body construction came in for searching analysis when D. W. Sherman, chief engineer, automotive division, A. O. Smith Corp., Milwaukee, appeared as principal speaker at the April 29 meeting of the Detroit Section. Respective merits of unitary types compared with conventional frame and body structure were presented by Mr. Sherman – with the weight of his conclusions thrown toward an improved structure consisting of a separate frame and body.

Complexities of the problem of deciding on the correct type of construction for future automobiles are increased, the speaker declared, because the problem does not lend itself to mathematical analysis and it is necessary to proceed largely on the basis of experimentation.

"Not so long ago there was a quite general feeling that the use of the car body as the sole supplier of the car's structural requirements could not help but show large savings in both weight and cost," Mr. Sherman declared, adding that experimentally it has since been shown that the separate frame structure can result in certain mechanical advantages which the unitary construction does not have, even though the more unyielding joints of the unitary construction give an advantage in rigidity. "It is necessary," he asserted, "to evaluate these qualities and to consider their effects on car ride and their influence on the eventual ratio between car performance, car weight, and car costs."

Because it is impossible to predict ahead of time whether ride will be harsh or soft, Mr. Sherman said that with the unitary design it would prove difficult to tune the car to the best rigidity range. However, with the separate frame, the most favorable set of conditions can be introduced by varying the hardness of the body shimming. He stated that it recently has been discovered that designs so far have not allowed the industry to obtain full advantage of the inherent ratio between the values of the frame and body separately, and of the two together.

By analogy he compared the separate frame and body construction to that of a leaf spring having two leaves, and the unitary construction to that of a leaf spring having only one leaf. In the two-leaved design, characteristics can be altered by decreasing or increasing resistance between the leaves and


Small Device . . .
BIG
RESPONSIBILITY
Great Performance
● "Cooling system thermostatically controlled" says the sales literature. Sounds good to the customer whether he understands it or not. If he does, he will expect to receive the improved performance and all the economies of oil and gasoline that go with accurate motor temperature control.
Now, in comparing his own with other cars he may drive in competitive demonstrations, will he ever think of the thermostat again? Probably not!
Yet month after month the same thermostat must respond uniformly to the motor's demands under all conditions of road, load, weather or pump pressure—taking care of the car's reputation for pep, performance and fuel economy.
For a responsible job like this, you had better standardize on Dole Thermostats with the non-fatiguing Dole Thermostatic Bi-Metal element.
THE DOLE VALVE COMPANY
1901-1941 Carroll Ave. · Chicago, Ill.
Detroit Office: General Motors Bldg.
DOLE
THERMOSTATS and
THERMOSTATIC BI-METAL

University of Michigan

(Concluded from page 70)

Of the 12,500 students in the 13 colleges of the University, about 2500 are in the College of Engineering. The engineering curriculum is divided into 12 departments, and it is interesting to note that the aeronautical engineering department dates back more than 25 years.

The operating equipment of the automotive laboratory includes 25 internal-combustion engines. It has six electric dynamometers with capacities varying from 30 to 300 hp, water and fan brakes, and several engine test stands of the reaction type, plus all of the additional equipment needed to test completely an internal-combustion engine.

Considerable development work is done by the automotive department faculty. Students help to run tests and gather data. At the present time work is under way on seat cushions and, as a part of the study, more than 500 individuals have been measured for cushion comfort. Development work and proof testing have been done on fan belts, piston rings, cylinder heads, bearings, and many other parts.

The University of Michigan is an affiliate member of the SAE, and its representative is William W. Bishop, librarian. There are 15 libraries on the campus which contain in the aggregate 988,000 volumes. The Transportation Library has 100,000 items dealing with every phase of transportation.

SAE members on the University of Michigan faculty include: Prof. E. A. Stalker, head of the department of aeronautical engineering; W. E. Lay, professor of mechanical engineering; H. E. Keeler, professor of mechanical engineering; E. T. Vincent, professor of mechanical engineering; G. G. Brown, professor of chemical engineering; J. M. Nickelsen, associate professor of mechanical engineering; C. W. Good, associate professor of mechanical engineering; H. L. Kohler, assistant professor of mechanical engineering.

energy can be dissipated by introducing inserts which have high damping value. However, in the single leaf design adjustments cannot be made.

Denying that the car body is at all representative of a large box structure, Mr. Sherman declared that "the stiffest all-steel body tested has a torque value of only 10,702 ft-lb per deg. The calculated stiffness of a true box having the average dimensions of a car body," he said, "and having the same panel thickness, approximates 600,000 ft-lb per deg," he stated. Thus the car body is found to be only 1.8 per cent as stiff as it might appear to be. Similarly, he indicated the bending stiffness is not as great as it appears to be.

Inability to insulate between frame and body in unitary construction was cited as another disadvantage of this type of structure. Road noise, it was indicated, can better be controlled in the conventional design. Opinions offered in the author's summation included:

"1. By substituting a unit type construction for a separate frame it should be possible, we believe, to reduce the weight of the average car of today by approximately 100 lb, still maintaining its riding and quietness qualities. To accomplish this result there must be no restriction on the time available for development. While the preliminary design might fortunately fall within a desirable range of conditions, it probably will not and considerable time will be required for structural alterations. Under the most favorable circumstances, we would expect the cost of this car to be somewhat higher than the car with separate frame. Should models be changed yearly, it is doubtful if weight could be saved, and the cost might get out of hand.

"2. Considering the car body and frame purely as a structure – it should be possible to achieve practically the same rigidity-weight ratio with bolted connections between lower and upper structure as with welded connections. The welded set-up might save 25 lb.

"3. The separate frame and body is due for considerable improvement within the next few years. X-members are on the way out; we have demonstrated other means for introducing adequate rigidity. The next step, and a step which looks very promising at this stage of the game, should result in a decided improvement in car performance. This improvement, we believe, will be such that a new standard will be set for car performance, one which cannot be obtained without a separate frame."

Student Branch Elects Officers for Next Year

■ Oregon State

At a recent meeting of the SAE Oregon State College Student Branch, officers were elected for the forthcoming year. They are: Harry Fall, chairman; Robert French, vice chairman, and Donald Olsen, secretary-treasurer.

Following the announcement of new officers, Harley Drake, superintendent of equipment, Pacific Highway Transport, gave a talk on requirements of personnel in industry.

On the completion of Mr. Drake's discussion, J. C. McGowan, chief engineer for the General Petroleum Corp., presented a motion picture entitled "Down to Earth" dealing with the problem of proper lubrication of farm machinery.

Important Changes in 1940 SAE Handbook

Now on the desks of SAE members is the 834-page 1940 edition of the SAE Handbook. Copies were mailed early last month.

Heading the list of 9 important new standards are the Aeronautical Material Specifications, which have been termed vital in production for national defense, and the Aircraft Engine Test Code.

No less valuable to the automotive industry are the new SAE Standards and Specifications on Extra-Light Radial Bearings, Sealed-Beam Headlamp Units, Vibration Testing Machine (Lamps), Viscosity Ranges (Equivalents) Trailer Fifth-Wheel Kingpins, Tap Drills, and Magnesium Alloys.

Additions and/or revisions have brought up-to-date 28 other standards or specifications, and 9 have been cancelled. These are listed on pp. x and xi of the new Handbook.

Additional copies of the Handbook are available to SAE members at $2.50 each. The price to non-members is $5.

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Diesel and Butane Forum Evokes "Hot" Discussion

■ *So. California*

Gasoline-powered heavy-duty trucks received blows from all sides, as exponents of high-speed diesel engines and of gasoline engines converted to use of butane as fuel took the floor at the Southern California Section's May 10 meeting. Each claimed superiority over the other and all four authors were in agreement that the gasoline-burning truck is the least economical in heavy-duty long-haul operations. The result was one of the "hottest" meetings ever held by the Section.

Leading off for the butane supporters was E. E. Tattersfield, Electric & Carburetor Engineering Co., who, in a brief history of the development of butane as a motor-truck fuel, placed its birth in the early months of 1928. At that time, he said, engineers of the Richfield Oil Co. decided that it was high time to harness some of the tremendous quantities of butanes and propanes that were being blown or torched to the open air. Their tests proved without doubt, he declared, that butane could be used to operate motor vehicles, and soon several companies developed devices for utilizing it in commercial operations.

Now, he said, it is safe to say that between 15,000 and 16,000 trucks, buses, and tractors on the Pacific Coast are using this fuel.

Mr. Tattersfield declared that the future of the butane industry, in so far as the motor truck is concerned, lies in the hands of the engine manufacturer. "During the past 12 years," he said, "we have been converting wet-fuel engines to burn dry gas. This has been done with a remarkable degree of success, but cannot possibly approach what can be done if the engine is designed specifically for dry-gas operation."

Coming next on the program, A. G. Bodine, American Liquid Gas Corp., gave an analysis of the combustion and chemical characteristics of liquefiable petroleum gases. Commonly known as "butane," and consisting of a mixture of butane and propane, this type of fuel has many properties halfway between the recognized properties of natural gas and gasoline, he explained. These characteristics, he added, give butane a number of advantages as a motor fuel.

"In quick review of the salient features of the gaseous motor fuels as compared with liquid motor fuels, we can safely say," said Mr. Bodine, "that their mixture with air is more uniform, absorbs less heat at important phases of the cycle, has a lower luminosity heat loss, burns more evenly and burns more completely without the formation of interstage oxidation products such as lacquers and gums. If for no other reason than the higher hydrogen percentage, we can expect more heat units from a pound of air as well as from a pound of fuel. We do not have to sacrifice power output for fuel economy."

"Utilization of Butane in Heavy-Duty Automotive Equipment," was the title of the third paper on the program, presented by C. L. Parkhill, Parkhill-Wade. A summary of the advantages of butane set forth by Mr. Parkhill follows:

1. Butane operation results in substantially the same mileage and, in some cases, better mileage than that obtained from gasoline. It will deliver less mileage than diesel fuel, but compensates for this with other economic advantages.
2. It will deliver the same horsepower with lower engine weight than the diesel.
3. Butane sells locally (Los Angeles) at 10¢ per gal; the same price as diesel fuel and 50% less than the contract price of even second-structure gasoline.
4. With butane there is a total absence of trailing exhaust smoke, and obnoxious, nauseating exhaust odors.
5. Oil drain periods are extended, when butane is used, to 7500, 10,000, and even 15,000 miles.
6. The capital investment in an Otto-cycle engine adapted to butane operation is far less than the capital invested in a diesel engine of similar horsepower.
7. The butane engine will amortize its cost more rapidly than the diesel engine.
8. Engine maintenance costs are greatly reduced.

Touching on bearings, he said: "Undoubtedly some of you are wondering just what I will have to say on this vital subject. I will answer your unvoiced question by admitting that there have been quite a few bearing failures in certain butane operations. At the same time I want to point out that those bearing changes can be charged, not to the fuel, but to misunderstanding on the part of certain individuals who thought themselves capable of making butane conversions."

SAE Coming Events

Oct. 14
Annual Dinner
Hotel Commodore – New York City

■

Sept. 24 – 25
National Tractor Meeting
Schroeder Hotel – Milwaukee, Wis.

■

Aug. 16 – 17
West Coast Transportation & Maintenance Meeting
New Washington Hotel – Seattle, Wash.

■

Oct. 31, Nov. 1 – 2
National Aircraft Production Meeting (and Engineering Display)
Hotel Biltmore – Los Angeles

■

November
Fuels & Lubricants Meeting
Tulsa, Okla.

■

Jan. 6 – 10, 1941
Annual Meeting
(and Engineering Display)
Book-Cadillac Hotel – Detroit

Baltimore – July 17
Barrison Grove, Md.; annual Crab Feast